A Review of the Amphibians and Reptiles of the Lake Superior Watershed

Technical Report provided to the Terrestrial Wildlife Community Committee, for the Lake Superior Lakewide Management Plan

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by Gary S Casper
Milwaukee Public Museum, 800 W Wells St, Milwaukee, WI 53233.414-278-2766, gsc@mpm.edu

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Introduction

The Lake Superior Binational Program represents a partnership of federal, state, provincial, and Tribal/First Nation governments working together with citizens to ensure the protection of the Lake Superior watershed. It has completed a Lake Superior Lakewide Management Plan (http://www.epa.gov/glnpo/lakesuperior/lamp2000/index.html), which has identified a need to expand current knowledge of amphibians and reptiles in the Lake Superior watershed (LSW). The Terrestrial Wildlife Community Committee (TWCC) of the Lake Superior Binational Program has a mission to support a diverse, healthy, and sustainable native wildlife community in the Lake Superior basin. Terrestrial wildlife includes plants, animals, and associated microorganisms.

The goals of the Terrestrial Wildlife Community Committee will be met when:

- There is a diverse, healthy, and sustainable native wildlife community in the Lake Superior basin.
- There is a wildlife community-based program to monitor the health of ecosystems in the Lake Superior basin.
- Species at risk/concern (federally threatened and endangered) are recovered.

Gaps in information about amphibians and reptiles identified by the TWCC include:

- Development of, and cross-agency agreements to adhere to, standard monitoring protocols for amphibian and reptile surveys.
- Implementation of more routes and surveys for all amphibian and reptile monitoring programs in the Lake Superior basin, especially for reptile species.
- Compilation of existing information on all amphibian and reptile species for the Lake Superior basin.
- Identifying reasons for population changes for amphibians and reptiles.
- Identifying appropriate conservation and management practices for amphibians and reptiles in the region.

This review is meant to begin filling these information gaps on amphibians and reptiles in the region, by reviewing and summarizing existing knowledge, activity and needs.

Methods

Herp occurrence in the Lake Superior watershed was evaluated by examining the literature, by collecting data from collections databases (where accessible), and by reviewing area atlassing and monitoring projects. Inquiries were made to all major universities and museums thought to house material from the study area. A number of institutions did not respond or did not have computerized records. Most notably absent from this review are significant collections of Minnesota material from the James Ford Bell Museum of Natural History (Minneapolis, MN), and Ontario material from the Royal Ontario Museum. Both of these collections, however, were captured by secondary sources (Oldfield and Moriarty, 1994; and Ontario Herpetofaunal Atlas; respectively). Collections data were available from the following collections:

American Museum of Natural History, New York, NY
California Academy of Sciences, San Francisco, CA

Carnegie Museum, Pittsburgh, PA
Chicago Academy of Sciences, IL
Cornell University, Ithaca, NY
Field Museum of Natural History, Chicago, IL
Illinois Natural History Survey, Champaigne, IL
James Ford Bell Museum of Natural History, Minneapolis, MN (Wisconsin material only)
Kansas University Museum of Natural History, Lawrence, KA
Los Angeles County Museum of Natural History, Los Angeles, CA
Milwaukee Public Museum, Milwaukee, WI
Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM
Ohio University, Athens, OH
Richter Museum, University of Wisconsin, Green Bay, WI
Sam Noble Oklahoma Museum of Natural History, Norman, OK
Southern Illinois University, Carbondale, IL
Tulane University, Baton Rouge, LA
United States National Museum, Washington, DC
University of California at Berkely, Museum Vertebrate Zoology, Berkely, CA
University of Colorado at Boulder, CO
University of Illinois Museum of Natural History, Urbana, IL
University of Michigan, Ann Arbor, MI
University of Nebraska, Lincoln, NE
University of Wisconsin, Stevens Point, WI (Wisconsin material only)
University of Wisconsin, Madison, WI (Wisconsin material only)
University of Wisconsin, Superior, WI (Wisconsin material only)

Where possible georeferenced digital maps were obtained of herp occurrence data, and these incorporated into an ArcView Geographic Information System project. Digitized occurrences from the Wisconsin Herp Atlas, the Marsh Monitoring Program, and the Ontario Herpetofaunal Atlas were obtained. These were supplemented by producing county level resolution range maps for Minnesota and Michigan based on standard literature references and digitized maps from the web site for the Herpetology Collection at the University of Michigan Ann Arbor (http://www.ummz.lsa.umich.edu/herps/miherps/). County level resolution shading was also produced for Wisconsin species tracked by the Wisconsin Frog and Toad Survey (which data have not yet been incorporated into the Wisconsin Herp Atlas). Maps were proofed against the occurrence database compiled for this project, and records were added to digital maps only if the location was not already mapped by other sources. The resulting species maps have mixed resolutions, and were used to evaluate species distribution in the LSW.

Pertinent literature was reviewed for the study area. A bibliography was compiled. Existing research and monitoring programs were canvassed and brief summaries are provided.

Amphibian and Reptile Record Review

The database compiled from institutional collections, atlassing and monitoring projects, contained 12,166 records for 47 species in the LSW. Records for 5 species were considered errors (*Ambystoma texanum, Bufo fowleri, Acris crepitans, Sternotherus odoratus, Thamnophis radix*), and records for 4 species were from just outside of the LSW boundaries (*Ambystoma jeffersonianum, Coluber constrictor, Thamnophis sauritus, Regina septemvittata, Sistrurus*

catenatus), and are considered hypothetical in the LSW. Record types are variable. Observation reports (N = 4,769) were obtained from monitoring and atlassing projects, as well as the literature. Cataloged specimen records (N = 7,322) were obtained from 26 institutions (see Appendix 1). One institution (MPM) also maintains cataloged photographs and audio tapes (N = 75). Verification of records was beyond the scope of this project, but if records were thought to be in error this is noted in species accounts. Species data are discussed below.

Amphibian and Reptile Diversity in the Lake Superior Watershed

The Lake Superior watershed encompasses portions of Minnesota, Wisconsin, Michigan and Ontario (Figure 1). Thirty-seven amphibian and reptile species are found within the watershed. An additional 10 species are reviewed for erroneous, marginal or potential occurrence in the watershed. Taxonomy follows Crother (2000).

Species List: These species occur in and are considered ecologically significant components of the watershed.

Caudata: Salamanders (7 species plus unisexual biotypes)

- Family Proteidae: Mudpuppies
  - Common Mudpuppy, *Necturus maculosus maculosus*
- Family Salamandridae: Newts
  - Eastern Newt, *Notophthalmus viridescens*
    - Red-spotted Newt, *Notophthalmus viridescens viridescens*
    - Central Newt, *Notophthalmus viridescens louisianensis*
- Family Ambystomatidae: Mole Salamanders
  - Spotted Salamander, *Ambystoma maculatum*
  - Eastern Tiger Salamander, *Ambystoma tigrinum tigrinum*
  - Blue-spotted Salamander, *Ambystoma laterale*
    - Unisexual *Ambystoma*
      - Tremblay's Salamander, *Ambystoma tremblayi*
      - various polyploid Ambystomids
- Family Plethodontidae: Lungless Salamanders
  - Four-toed Salamander, *Hemidactylium scutatum*
  - Eastern Red-backed Salamander, *Plethodon cinereus*

Anura: Frogs and Toads (12 species)

- Family Bufonidae: True Toads
  - Eastern American Toad, *Bufo americanus americanus*
- Family Hylidae: Treefrogs and Relatives
  - Western Chorus Frog, *Pseudacris triseriata*
  - Boreal Chorus Frog, *Pseudacris maculata*
  - Northern Spring Peeper, *Pseudacris crucifer crucifer*
  - Eastern Gray Treefrog, *Hyla versicolor*
  - Cope's Gray Treefrog, *Hyla chrysoscelis*
    - Treefrog species, *Hyla* sp
- Family Ranidae: Typical Frogs
  - American Bullfrog, *Rana catesbeiana*
  - Northern Green Frog, *Rana clamitans melanota*
  - Mink Frog, *Rana septentrionalis*
  - Wood Frog, *Rana sylvatica*

Northern Leopard Frog, *Rana pipiens*
Pickerel Frog, *Rana palustris*

Testudines: Turtles (6 species)
Family Chelydridae: Snapping Turtles
Eastern Snapping Turtle, *Chelydra serpentina serpentina*
Family Emydidae: Pond and Box Turtles
Wood Turtle, *Clemmys insculpta*
Blanding's Turtle, *Emydoidea blandingii*
Painted Turtle, *Chrysemys picta*
Western Painted Turtle, *Chrysemys picta bellii*
Midland Painted Turtle, *Chrysemys picta marginata*
Northern Map Turtle, *Graptemys geographica*
Family Trionychidae: Softshell Turtles
Eastern Spiny Softshell, *Apalone spinifera spinifera*

Squamata, Lacertilia: Lizards (2 species)
Family Scincidae: Skinks
Common Five-lined Skink, *Eumeces fasciatus*
Northern Prairie Skink, *Eumeces septentrionalis septentrionalis*

Squamata, Serpentes: Snakes (10 species)
Family Colubridae: Typical Snakes
Northern Ring-necked Snake, *Diadophis punctatus edwardsii*
Smooth Greensnake, *Opheodrys vernalis*
Western Foxsnake, *Elaphe vulpina vulpina*
Eastern Milksnake, *Lampropeltis triangulum triangulum*
Eastern Hog-nosed Snake, *Heterodon platirhinos*
Bullsnake, *Pituophis catenifer sayi*
Dekay's Brownsnake, *Storeria dekayi*
Northern Red-bellied Snake, *Storeria occipitomaculata occipitomaculata*
Common Gartersnake, *Thamnophis sirtalis*
Red-sided Gartersnake, *Thamnophis sirtalis parietalis*
Eastern Gartersnake, *Thamnophis sirtalis sirtalis*
Northern Watersnake, *Nerodia sipedon sipedon*

Erroneous, Marginal or Hypothetical Species:

These species have range limits just shy of the watershed, or are considered erroneous or hypothetical.

Jefferson Salamander, *Ambystoma jeffersonianum*
Small-mouthed Salamander, *Ambystoma texanum*
Fowler's Toad, *Bufo fowleri*
Blanchard's Cricket Frog, *Acris crepitans blanchardi*
Common Musk Turtle, *Sternotherus odoratus*
Racer, *Coluber constrictor*
Plains Gartersnake, *Thamnophis radix*
Eastern Ribbonsnake, *Thamnophis sauritus*
Queen Snake, *Regina septemvittata*
Eastern Massasauga, *Sistrurus catenatus catenatus*

Species Accounts

SALAMANDERS

Common Mudpuppy, *Necturus maculosus maculosus*, Figure 2.

Common Mudpuppies are widespread but locally distributed throughout the region, being rare or absent from the north shore of Lake Superior and the boreal forest north of the lake. Records from Thunder Bay stand out on the north shore. Mudpuppies are more common in inland lakes and rivers than in the cold waters of Lake Superior itself. Within Lake Superior Mudpuppies tend to congregate in harbors and river mouths where warmer water and higher biotic productivity occurs. Being entirely aquatic and relatively long lived, Mudpuppies can accumulate chemical loads, and are reportedly sensitive to contaminants such as rotenone and TFM lampricides (Sand, 1975; Matson, 1990; Gendron, et al., 1994; Bonin et al., 1995; Gendron, et al., 1997; Boogaard, in review), with mortality reported for 32% of Lake Superior tributaries (Gilderhaus and Johnson, 1980). There are some suggestions of declines in the United States (Harding, 1997), but no declines are reported from Ontario (Weller and Green, 1997). Quantitative trend data are scarce, and status and trends in the LSW are largely unknown. Status, conservation and habitat needs are reviewed in Lannoo (in press), and Petranka (1998). Specimens from the LSW are available at (but not necessarily limited to) the CASSF, FMNH, INHS, JFBM, MPM, UIMNH, UMMZ, USNM, UWS, UWSP, and UWZ (Appendix 1).

Eastern Newt, *Notophthalmus viridescens*, Figure 3.

Eastern Newts are common in the LSW, except for the central north shore region, which represents a gap between the ranges of the two subspecies. The Red-spotted Newt, *N. v. viridescens*, occurs in Ontario at the far eastern end of the LSW, while the remainder of the region is occupied by the Central Newt, *N. v. louisianensis*. There is no evidence of declines, but quantitative trend data are not available. Status, conservation and habitat needs are reviewed in Lannoo (in press). Newts are considered uncommon and sparsely distributed in extreme southwestern Ontario (Weller and Green, 1997). Specimens from the LSW are available at (but not necessarily limited to) the CM, FMNH, MPM, UMMZ, USNM, UWS, UWSP, and UWZ (Appendix 1).

Spotted Salamander, *Ambystoma maculatum*, Figure 4.

Mature deciduous forests with vernal ponds offer optimal habitat for the Spotted Salamander, which occurs throughout the LSW, with the exception of being apparently absent from northeastern Minnesota. The LSW encompasses the western limit of the range in Ontario and Minnesota, and this limit is still being refined through survey work. Spotted Salamanders were first found in extreme northwestern Wisconsin in 1996 (Casper, 1996a), and in Pine County, Minnesota, in 2001. Trend and status data are lacking, but their habitat requirements suggest that, as in other pond-breeding species, they could be adversely affected by deforestation and wetland destruction (Petranka, 1998). Habitat loss, acidification, metal concentrations, environmental contaminants, and fish introductions are factors that could contribute to declines of spotted salamanders, and some have been shown to negatively affect this species (Pough,

1976; Tome and Pough, 1982; Clark, 1986; Portnoy, 1990; Blem and Blem, 1989, 1991; Sadinski and Dunson, 1992; Brodman, 1993; Rowe and Dunson, 1993; Sexton et al., 1994; but see Cook, 1983; Clay, 1997; see also Petranka, 1998). They likely have declined where mature forests have been replaced by younger stands, and where losses of ephemeral wetlands are progressing. Status, conservation and habitat needs are reviewed in Lannoo (in press). Spotted Salamanders are considered uncommon and sparsely distributed in extreme southwestern Ontario, with the range extending north to Lake Nipigon and Atikokan areas in northwest Ontario (Weller and Green, 1997). Specimens from the LSW are available at (but not necessarily limited to) the FMNH, MPM, MVZ, RM, UMMZ, UWS, UWSP, and UWZ (Appendix 1).

Eastern Tiger Salamander, *Ambystoma tigrinum tigrinum*, Figure 5.

Eastern Tiger Salamanders reach their northern range limit in the southern portion of the LSW, where they are uncommon and local. There is an isolated population in Alger County, Michigan, and the species comes into the region in northwestern Wisconsin and northeastern Minnesota. It is not present in the Ontario portion of the LSW. No status or trend information is available. Eastern Tiger Salamanders are sensitive to acidification of breeding ponds, and fish introductions (see Petranka, 1998). Status, conservation and habitat needs are reviewed in Lannoo (in press). Specimens from the LSW are available at (but not necessarily limited to) the MPM and UWS (Appendix 1).

Blue-spotted Salamander, *Ambystoma laterale* complex, Figure 6.

Blue-spotted Salamanders are ubiquitous throughout the LSW. This species and the closely related Jefferson Salamander (*A. jeffersonianum*) produce a number of polyploid lineages which have been described from the LSW, including the unisexual *Ambystoma tremblayi*. These complex relations are most recently summarized in Petranka (1998), and Phillips and Mui (in press), to which the reader is referred. Unisexual salamanders can often only be identified by techniques such as karyology or protein electrophoresis, and are usually dependant upon their associated diploid "hosts" for successful reproduction through sperm activation, but not fertilization, of eggs. Therefore, while investigations continue into the taxonomic status of these lineages, and whether or not they should be given conservation recognition, conservation measures directed towards the diploid species will also benefit the unisexual polyploids. The latter, however, are certainly much less common and represent unique evolutionary units, factors which argue for conservation and monitoring of genetics (Galbraith, 1997; Rye et al., 1997). Blue-spotted Salamanders are common throughout the LSW, with no evidence of decline. However, trend and status data are lacking, and like other pond-breeding species, they could be adversely affected by deforestation, fish introductions, acid deposition, and wetland destruction (Petranka, 1998). They likely have declined where mature forests have been replaced by younger stands, and where losses of ephemeral wetlands are progressing. Status, conservation and habitat needs are reviewed in Lannoo (in press). Specimens from the LSW are available at (but not necessarily limited to) the CM, FMNH, INHS, JFBM, MPM, MVZ, RM, UIMNH, UMMZ, USNM, UWS, UWSP and UWZ (Appendix 1).

Four-toed Salamander, *Hemidactylium scutatum*, Figure 7.

Four-toed Salamanders enter the southern portion of the LSW, but records are spotty. These salamanders have rather particular breeding requirements, associated with mature hardwood forests and wetlands with good moss development. In recent years significant range expansions in Minnesota and Wisconsin have resulted from focused survey work directed specifically towards this species, indicating that it is more widespread than once thought (Dorf, 1995; Casper, 1996a-c; Casper, 1999; Casper, 2000; Hall et al., 2000). However, Four-toed Salamanders do appear to be absent from the boreal forests north of Lake Superior, and surveys in Cook and Lake counties in Minnesota have not been successful in finding them. They likely have declined where cool, moist, mature hardwood forests have been replaced by conifers or younger hardwoods, and where losses of small wetlands are progressing (see Petranka, 1998). Status, conservation and habitat needs are reviewed in Lannoo (in press). Specimens from the LSW are available at (but not necessarily limited to) the CM, JFBM, MPM, RM, UMMZ, UWS, UWSP and UWZ (Appendix 1).

Eastern Red-backed Salamander, *Plethodon cinereus*, Figure 8.

Eastern Red-backed Salamanders are ubiquitous throughout the LSW, but reach the northern limit of their range inland from the north shore of Lake Superior. A forest obligate and terrestrial breeder, they are probably the most abundant salamander in the region. However, they are sensitive to acid soils, and are at risk from forestry practices which result in clear cutting and increasingly younger ages of timber stands (see Casper, in press; Petranka, 1998). Studies suggest that salamander populations require 30-60 years to recover from clear cutting and intensive timber harvests (Petranka, et al., 1993; Petranka, 1998). Some quantitative data on abundance and trends is available from other regions (see Casper, in press), but little is known of status within the LSW. Status, conservation and habitat needs are reviewed in Lannoo (in press). Specimens from the LSW are available at (but not necessarily limited to) the AMNH, CM, FMNH, INHS, MPM, MSWB, MVZ, RM, UMMZ, USNM, UWS, UWSP and UWZ (Appendix 1).

FROGS AND TOADS

Eastern American Toad, *Bufo americanus americanus*, Figure 9.

Eastern American Toads are common and widespread throughout the LSW. There is no evidence of decline, and toads are generally more tolerant of habitat degradation than most amphibians. However, like many other amphibian species, they are susceptible to habitat loss, and larvae are susceptible to low pH (see Green, in press). The Wisconsin Frog and Toad Survey data indicate a stable or increasing trend (Mossman et al., 1998). Status, conservation and habitat needs are reviewed in Lannoo (in press). Specimens from the LSW are available at (but not necessarily limited to) the AMNH, CASSF, CM, FMNH, INHS, JFBM, MPM, MSWB, MVZ, OU, RM, UCB, UIMNH, UMMZ, USNM, UWS, UWSP and UWZ (Appendix 1).

Chorus Frogs, *Pseudacris* sp, Figure 10.

Both Western, *Pseudacris triseriata*, and Boreal, *Pseudacris maculata*, chorus frogs occur in the LSW. The Boreal Chorus Frog was only recently elevated to specific status, and

regional survey efforts are still refining the range boundaries of the two species, which are thought to hybridize in northwestern Wisconsin (Platz and Forester, 1988; Platz, 1989). In Michigan, Boreal Chorus Frogs are found only on Isle Royale (Harding and Holman, 1992). All Ontario records in the LSW are identified as *P. maculata*, which is considered common and widespread throughout northern Ontario (Weller and Green, 1997; Ontario Herpetofaunal Atlas). The distributions of the two species in Minnesota have yet to be worked out (Oldfield and Moriarty, 1994), but specimens in the Lake Superior north shore region are likely to be *P. maculata*, while *P. triseriata* or hybrids may predominate in the extreme southwestern portion of the LSW. Western/Boreal Chorus Frogs are uncommon and spottily distributed in northern Wisconsin and Michigan. Status, conservation and habitat needs are reviewed in Lannoo (in press). Specimens from the LSW are available at (but not necessarily limited to) the FMNH, MPM, OU, UMMZ, UNL, USNM, UWS, UWSP and UWZ (Appendix 1).

Northern Spring Peeper, *Pseudacris crucifer crucifer*, Figure 11.

Northern Spring Peepers are found throughout the LSW. They are sparsely distributed in extreme southwestern Ontario, with a single report from northwestern Ontario near Sachigo Lake (Weller and Green, 1997). Declines reported from the Toronto region are attributed to urbanization and habitat modification (Weller and Green, 1997). The Wisconsin Frog and Toad Survey trend is negative (Mossman et al., 1998). Status, conservation and habitat needs are reviewed in Lannoo (in press). Specimens from the LSW are available at (but not necessarily limited to) the AMNH, CM, FMNH, INHS, MPM, MVZ, RM, UIMNH, UMMZ, USNM, UWS, UWSP and UWZ (Appendix 1).

Cope's Gray Treefrog, *Hyla chrysoscelis*, Figure 12.

In the LSW, Cope's Gray Treefrog enters into the southern part of the region, typically in scattered locations in barrens habitats. Since older treefrog records often cannot be assigned to a species, relative distributions of the two treefrog species is still being worked out (see Cline, in press). The Wisconsin Frog and Toad Survey data indicate a significant 2.4% mean annual decline in frequency from 1984 to 1995 (Mossman et al., 1998), one of the largest declines noted in their analyses. Status, conservation and habitat needs are reviewed in Lannoo (in press). *Hyla* specimens from the LSW are available at (but not necessarily limited to) the AMNH, CASSF, FMNH, JFBM, KU, MPM, RM, UIMNH, UMMZ, USNM, UWS, UWSP and UWZ (Appendix 1).

Eastern Gray Treefrog, *Hyla versicolor*, Figure 13.

In the LSW, Eastern Gray Treefrogs are found throughout the region except most of the north shore of Lake Superior and the boreal forest to the north. They are sparsely distributed in extreme southwestern Ontario (Weller and Green, 1997). They often occur in sympatry with Cope's Gray Treefrogs in the southern LSW. The Wisconsin Frog and Toad Survey data indicate a stable or increasing trend (Mossman et al., 1998). Status, conservation and habitat needs are reviewed in Lannoo (in press). *Hyla* specimens from the LSW are available at (but not necessarily limited to) the AMNH, CASSF, FMNH, JFBM, KU, MPM, RM, UIMNH, UMMZ, USNM, UWS, UWSP and UWZ (Appendix 1).

American Bullfrog, *Rana catesbeiana*, Figure 14.

In the LSW, American Bullfrogs enter into the southern part of the watershed, but are absent from the western and northern portions. Few data are available on trends. Local extirpations have been reported in southwestern Ontario (Hecnar, 1997; Weller and Green, 1997). Shirose and Brooks (1997) estimated that bullfrog populations in Algonquin Park, Ontario, likely fluctuate by as much as 50 - 80%, even in the absence of long-term trends in population size. Bullfrogs are inadequately sampled by the Wisconsin Frog and Toad Survey (Mossman et al., 1998). Status, conservation and habitat needs are reviewed in Lannoo (in press). Specimens from the LSW are available at (but not necessarily limited to) the CASSF, FMNH, INHS, JFBM, MPM, MVZ, UMMZ, USNM, UWS, UWSP and UWZ (Appendix 1).

Northern Green Frog, *Rana clamitans melanota*, Figure 15.

Northern Green Frogs are common throughout the LSW. Few data are available on trends. There are no indications of decline in Ontario, where it is considered widespread and common (Weller and Green, 1997). The Wisconsin Frog and Toad Survey trend is stable (Mossman et al., 1998). Status, conservation and habitat needs are reviewed in Lannoo (in press). Specimens from the LSW are available at (but not necessarily limited to) the AMNH, CM, FMNH, INHS, JFBM, MPM, MSWB, MVZ, OU, RM, UCB, UIMNH, UMMZ, USNM, UWS, UWSP and UWZ (Appendix 1).

Mink Frog, *Rana septentrionalis*, Figure 16.

Mink Frogs are found throughout the LSW. Few data are available on trends. Mossman et al.(1998) considered Mink Frogs uncommon to fairly common in the Wisconsin portion of the LSW, but sampling is inadequate for trend analysis in the Wisconsin Frog and Toad Survey. Status, conservation and habitat needs are reviewed in Lannoo (in press). Specimens from the LSW are available at (but not necessarily limited to) the AMNH, CASSF, CM, FMNH, INHS, JFBM, MPM, UIMNH, UMMZ, USNM, UWS and UWSP (Appendix 1).

Wood Frog, *Rana sylvatica*, Figure 17.

Wood Frogs are common throughout the LSW, but few data are available on trends. Wood Frogs are one of the more difficult species to monitor via calling surveys because of a very early, short, and explosive breeding season. They also respond quickly to drought (negatively). The Wisconsin Frog and Toad Survey trend is indeterminate because of these survey difficulties (Mossman et al., 1998). Status, conservation and habitat needs are reviewed in Lannoo (in press). Specimens from the LSW are available at (but not necessarily limited to) the AMNH, CASSF, CM, FMNH, INHS, MPM, MSWB, MVZ, RM, UIMNH, UMMZ, UNL, USNM, UWS, UWSP and UWZ (Appendix 1).

Northern Leopard Frog, *Rana pipiens*, Figure 18.

Northern Leopard Frogs are found throughout the LSW, but have suffered significant declines in many parts of the LSW. Northern Leopard Frogs are especially vulnerable to poor landscape management, due to the multiple habitat needs of a complex life cycle. Declines in

northern Ontario are discussed in Oldham and Weller (1992) and Seburn and Seburn (1997). Declines and extirpations were first observed in Wisconsin and Michigan in the late 1960s or early 1970s (Hine et al., 1981; Rittschof, 1975). Hoppe and McKinnell (1997) review Minnesota declines. Mossman et al.(1998) considered Northern Leopard Frogs common, but declining, especially in the LSW region of Wisconsin. Northern leopard frogs were common in southwestern Ontario, but declined from 1992 - '93 (Hecnar, 1997). Status, conservation and habitat needs are reviewed in Lannoo (in press). Specimens from the LSW are available at (but not necessarily limited to) the AMNH, CASSF, CM, FMNH, INHS, JFBM, MPM, OMNH, OU, UCB, UIMNH, UMMZ, USNM, UWS and UWSP (Appendix 1).

Pickerel Frog, *Rana palustris*, Figure 19.

In the LSW, Pickerel Frogs are found in the southern part of the watershed, but are absent from the western and northern portions. They are locally common but patchily distributed where they occur. Historical abundance and trends in the LSW are unknown. This species' somewhat specialized habitat requirements and its general intolerance of pollution may make it vulnerable to human activities (Redmer and Mierzwa, 1994; Harding, 1997). It is considered to be declining in Wisconsin (Casper, 1998; Mossman et al., 1998), and listed as a species of special concern in Wisconsin and (due to restricted range) in Minnesota (Oldfield and Moriarty, 1994). Pickerel Frogs are inadequately sampled by the Wisconsin Frog and Toad Survey, but a decline was significant in three of four analyses (Mossman et al., 1998). Status, conservation and habitat needs are reviewed in Lannoo (in press). Specimens from the LSW are available at (but not necessarily limited to) the MPM, OU, UMMZ and USNM (Appendix 1).

TURTLES

Eastern Snapping Turtle, *Chelydra serpentina serpentina*, Figure 20.

Eastern Snapping Turtles reach the northern limit of their range in the northern third of the LSW. In many areas, over harvest for human consumption has decimated Snapping Turtle populations (Ernst et al., 1994), although this is not yet indicated as a problem in the LSW. Exposure to chemical toxicants is widespread in Snapping Turtles, whose habit of frequenting sediments and propensity for long life predispose them to bioaccumulate toxins (see Ernst et al., 1994). Brooks et al. (1988) provide management recommendations and a life table. Biology is reviewed in Ernst et al. (1994). Specimens from the LSW are available at (but not necessarily limited to) the CM, FMNH, INHS, MPM, RM, UMMZ, UWS and UWSP (Appendix 1).

Wood Turtle, *Clemmys insculpta*, Figure 21.

Wood Turtles are limited to the southern portions of the LSW. Wood Turtles are a Threatened Species in Minnesota, and the St Louis and Lake county records are limited to a few streams near Lake Superior. Wood Turtles are considered a Threatened Species in Wisconsin, and Special Concern in Michigan and Ontario. The northern Wisconsin and Michigan populations are probably some of the best remaining populations in the global range of this species, and deserve protection. Wood Turtles are in decline throughout their global range due to collecting pressures and habitat destruction, including within the LSW (see Ernst et al., 1994).

Biology is reviewed in Ernst et al. (1994), with population density estimates given. Specimens from the LSW are available at (but not necessarily limited to) the CAS, CM, MPM, RM, UMMZ, UWS and UWZ (Appendix 1).

Blanding's Turtle, *Emydoidea blandingii*, Figure 22.

Blanding's Turtles are limited to the southern portions of the LSW, where they are rare and local at the northern limit of their range. The are listed as a Threatened Species in Minnesota and Wisconsin, and Special Concern in Michigan. Biology and demographics are reviewed in Ernst et al. (1994). Specimens from the LSW are available at (but not necessarily limited to) the MPM, UMMZ, USNM and UWS (Appendix 1).

Painted Turtle, *Chrysemys picta*, Figure 23.

Painted Turtles are found throughout the LSW and are the most widespread and abundant turtle species present. Two subspecies intergrade across the region, coming together about midway. The Western Painted Turtle, *Chrysemys picta bellii*, occupies Minnesota, Isle Royale, and western Wisconsin and Ontario. The Midland Painted Turtle, *C. p. marginata*, is found in eastern Ontario and eastern Michigan within the LSW. Biology and demographics are reviewed in Ernst et al. (1994). Specimens from the LSW are available at (but not necessarily limited to) the AMNH, CM, FMNH, INHS, MPM, MVZ, RM, TU, UMMZ, USNM, UWS, UWSP and UWZ (Appendix 1).

Northern Map Turtle, *Graptemys geographica*, Figure 24.

Northern Map Turtles just barely enter the LSW. A single specimen from Schoolcraft County, Michigan, was netted in Swan Lake in 1975 (UMMZ 142771). In Wisconsin, there are records from the Namekagon and St. Croix rivers in Douglas and Burnett counties. In Minnesota, the species is known only from Pine County. Biology and demographics are reviewed in Ernst et al. (1994). Specimens from the LSW are available at (but not necessarily limited to) the FMNH and UMMZ (Appendix 1).

Eastern Spiny Softshell, *Apalone spinifera spinifera*, Figure 25.

Eastern Spiny Softshells are found only in the southwestern portion of the LSW, where they reach their northern range limit. Biology and demographics are reviewed in Ernst et al. (1994). Specimens from the LSW are available at (but not necessarily limited to) the MPM (Appendix 1).

LIZARDS

Common Five-lined Skink, *Eumeces fasciatus*, Figure 26.

Common Five-lined Skinks are found only in the central Michigan portion of the LSW, where they reach their northern range limit. No data are available on status or trends. Specimens from the LSW are available at (but not necessarily limited to) the CM, MPM and UMMZ (Appendix 1).

Northern Prairie Skink, *Eumeces septentrionalis septentrionalis*, Figure 27.

Northern Prairie Skinks are found only in the southwestern portion of the LSW, in Minnesota and Wisconsin, where they reach their northern range limit in pine barrens. No data are available on status or trends. Specimens from the LSW are available at (but not necessarily limited to) the FMNH, MPM, UNL, USNM, UWS and UWZ (Appendix 1).

SNAKES

Northern Ring-necked Snake, *Diadophis punctatus edwardsii*, Figure 28.

Northern Ring-necked Snakes are found throughout all but the northern portion of the LSW. They are apparently absent from the boreal forests north of Lake Superior. In Michigan, the inclusion of Isle Royale in the range map published in Amphibians and Reptiles of the Great Lakes Region (Harding, 1997) is apparently an error (J. Harding personal communication, June 2002). The range map in Michigan Snakes (Holman et al., 1989) is correct. While no records exist for Isle Royale, this does not rule out their occurrence there. Ring-necked Snakes feed mainly on Eastern Red-backed Salamanders, and no data are available on status or trends. Specimens from the LSW are available at (but not necessarily limited to) the FMNH, MPM, UIMNH, UMMZ, UWS, UWSP and UWZ (Appendix 1).

Smooth Greensnake, *Opheodrys vernalis*, Figure 29.

Smooth Greensnakes are found in the southern portion of the LSW, absent from the boreal forests north of Lake Superior. In Michigan, the inclusion of Isle Royale in the range map published in Amphibians and Reptiles of the Great Lakes Region (Harding, 1997) is apparently an error (J. Harding personal communication, June 2002). The range map in Michigan Snakes (Holman et al., 1989) is correct. Smooth Greensnakes are insectivorous, and reach their highest abundance in sand soils. No data are available on status or trends. Specimens from the LSW are available at (but not necessarily limited to) the FMNH, INHS, JFBM, MPM, OU, RM, UMMZ, USNM, UWS, UWSP and UWZ (Appendix 1).

Western Foxsnake, *Elaphe vulpina vulpina*, Figure 30.

Western Foxsnakes occur only in the southern portion of the LSW. While some authors consider an eastern subspecies a distinct species (a.k.a. Eastern Foxsnake, *Elaphe gloydi*, see Crother, 2000), others await publication of quantitative character analyses before acceptance. The eastern taxon under dispute does not occur in the LSW. This large constrictor is common in parts of the Wisconsin and Michigan portion of the LSW, but no data are available on status or trends. Specimens from the LSW are available at (but not necessarily limited to) the CM, FMNH, JFBM, MPM, RM, UMMZ, USNM, UWS, UWSP and UWZ (Appendix 1).

Eastern Milksnake, *Lampropeltis triangulum triangulum*, Figure 31.

Eastern Milksnakes are quite rare in the LSW, with only a few records from Michigan, and from Ontario in the extreme eastern portion of the watershed. This represents the northern range limit. No data are available on trends. Specimens from the LSW are available at (but not necessarily limited to) the UMMZ (Appendix 1).

Eastern Hog-nosed Snake, *Heterodon platirhinos*, Figure 32.

Eastern Hog-nosed Snakes enter into the LSW region only in the southwest, representing a northern range limit. They prefer sandy soils and feed mainly on American Toads. No data are available on status or trends. Specimens from the LSW are available at (but not necessarily limited to) the FMNH, JFBM, MPM, OMNH, USNM, UWS, UWSP and UWZ (Appendix 1).

Bullsnake, *Pituophis catenifer sayi*, Figure 33.

Bullsnakes enter into the LSW region only in the southwest, representing a northern range limit. They prefer sandy soils and are associated with pine barrens in the southwest LSW. No data are available on status or trends. Specimens from the LSW are available at (but not necessarily limited to) the MPM (Appendix 1).

Dekay's Brownsnake, *Storeria dekayi*, Figure 34.

Dekay's Brownsnakes are uncommon in the LSW, with only a few records from Michigan, Wisconsin and Ontario in the southern portion of the watershed. In Michigan, the Keweenaw County record is a sight record considered reliable by J. Harding (personal communication, June 2002). Harding has observed *S. dekayi* in Schoolcraft County, and a Schoolcraft County specimen also resides at UMMZ (166598). Harding reports that snake densities in Michigan's Upper Peninsula are typically low, and not much survey work has been done on smaller species. He suspects that *S. dekayi* may be more widespread than records indicate. Specimens from the LSW are available at (but not necessarily limited to) the UMMZ and UWZ (Appendix 1).

Northern Red-bellied Snake, *Storeria occipitomaculata occipitomaculata*, Figure 35.

Northern Red-bellied Snakes are found throughout the southern portion of the LSW, but absent from the boreal forests of the north. They can reach very high abundance in many areas, and feed mainly on slugs. No data are available on status or trends. Specimens from the LSW are available at (but not necessarily limited to) the AMNH, CASSF, CM, CU, FMNH, INHS, JFBM, MPM, OU, SIU, UMMZ, UNL, USNM, UWS, UWSP and UWZ (Appendix 1).

Common Gartersnake, *Thamnophis sirtalis*, Figure 36.

Common Gartersnakes are common throughout the LSW, but no data are available on status or trends. Two subspecies occur. The Red-sided Gartersnake, *T. s. parietalis*, is found in western Ontario and northwestern Minnesota, while the Eastern Gartersnake, *T. s. sirtalis*, is found through the rest of the watershed. These two subspecies commingle across a broad band including all of the LSW portions of Minnesota, Wisconsin, and western Ontario. Common Gartersnakes are regionally abundant, especially around wetlands where frogs, their main prey, abound. Specimens from the LSW are available at (but not necessarily limited to) the AMNH, CASSF, CM, CU, FMNH, INHS, JFBM, LACM, MPM, OU, RM, UIMNH, UMMZ, USNM, UWS, UWSP and UWZ (Appendix 1).

Northern Watersnake, *Nerodia sipedon sipedon*, Figure 37.

Northern Watersnakes are found only in the southern portion of the LSW. They can be

locally common, but are likely sensitive to shoreline development, which is rampant in northern Wisconsin and Michigan. No data are available on status or trends. Specimens from the LSW are available at (but not necessarily limited to) the AMNH, CM, FMNH, JFBM, MPM, UIMNH, UMMZ, USNM, UWSP and UWZ (Appendix 1).

Erroneous, Marginal and Hypothetical Species Accounts

Jefferson Salamander, *Ambystoma jeffersonianum*:

Specimens now referred to the bisexual taxon *Ambystoma jeffersonianum* do not occur in the Lake Superior watershed (Petranka, 1998; Brodman, in press). In this review, 9 specimens residing in the FMNH collection were determined to *Ambystoma jeffersonianum* but with locality data merely given as "Ontario".

Small-mouthed Salamander, *Ambystoma texanum*:

This species does not occur in the Lake Superior watershed (Petranka, 1998). Evidence consists of one specimen at the University of Wisconsin Green Bay-Richter Museum (H236) purportedly from Forest County, Wisconsin. This specimen is likely a mis-identified *Ambystoma laterale.*

Fowler's Toad, *Bufo fowleri*:

Fowler's Toads are unlikely to have ever occurred in the Lake Superior watershed. Evidence consists of one unverified observation from the Wisconsin Herp Atlas (an observation from the Apostle Islands, LAC1 5, in 1957), which was almost certainly a mis-identified Eastern American Toad. Historically, the range of Fowler's Toads has not extended further north than southeast Iowa through northern Illinois, reaching the northern range limit on the west side of Michigan's Lower Peninsula, almost to the Mackinac Strait (Harding and Holman, 1992; Green, in press).

Blanchard's Cricket Frog, *Acris crepitans blanchardi*:

Blanchard's Cricket Frog are unlikely to have ever occurred in the Lake Superior watershed. Evidence consists of three unverified reports from the Wisconsin Herp Atlas (observations from Vilas and Ashland counties, DRIN 16 and STET 5, respectively; and UWZ specimen 3613 purportedly from the Apostle Islands), and 2 Wisconsin records from the Marsh Monitoring Program from Vilas and Bayfield counties. Historically, the range of this species has not extended further north than central Wisconsin (Casper, 1998), the lower third of Michigan (Harding and Holman, 1992), and extreme southern Ontario. Since this species can be confused with chorus frogs, and the calls confused with some marsh birds (rails), these records should be considered hypothetical unless additional evidence is obtained and verified. An examination of the specimen at UWZ is recommended.

Common Musk Turtle, *Sternotherus odoratus*

One museum specimen (Tulane University 752) was reportedly collected near Hayward (Sawyer County, Wisconsin), in 1936. The nearest accepted record is well to the south (Trempealeau County: Casper, 1996d). This specimen needs verification, and positive modern

field results should be obtained, before Musk Turtles are considered part of the LSW herpetofauna.

Racer, *Coluber constrictor*

An observation from Pine County, Minnesota is published (Oldfield and Moriarty, 1994). An isolated colony is reported from Menominee County, Michigan. Both these occurrences border the LSW. However, additional work should verify breeding populations in these areas before considering Racers to be a part of the LSW herpetofauna.

Plains Gartersnake, *Thamnophis radix*

Plains Gartersnakes are found just outside the LSW in Cass, Crow Wing and Kanabec counties, Minnesota (Oldfield and Moriarty, 1994). A western prairie species, they are not likely to occur within the LSW. One specimen listed at the University of Wisconsin, Madison, Zoology Museum (UWZ 2280) from Bayfield County, Wisconsin, is almost certainly erroneous, but has not been examined.

Northern Ribbonsnake, *Thamnophis sauritus septentrionalis*

Northern Ribbonsnakes are found just outside the LSW in Michigan's lower peninsula, and an isolated occurrence in northwestern Wisconsin (Harding, 1997). There is no evidence that the enter the LSW.

Queen Snake, *Regina septemvittata*

Known from Bois Blanc Island in the Straight of Mackinac, and southeastern Ontario, Queen Snakes are not expected to occur in the LSW.

Eastern Massasauga, *Sistrurus catenatus catenatus*

Known from Bois Blanc Island in the Straight of Mackinac, and southeastern Ontario, Eastern Massasaugas are not expected to occur in the LSW.

Monitoring Review

All states and provinces have calling frog survey programs in place (sometimes multiple programs), with Wisconsin's being the longest running (and a model for the others). All states and provinces also participate in the Natural Heritage Inventory, administered by The Nature Conservancy through cooperative agreements with provincial and state governments. Ontario and Wisconsin also have independent herp atlassing projects in place, both of which have data sharing agreements with their respective Natural Heritage Inventories. Regionally, the Marsh Monitoring Program includes the entire Great Lakes watershed, and collects limited herp data in the LSW. A variety of U.S. federal agency initiatives address amphibians in the LSW region, such as the North American Amphibian Monitoring Program, and the Amphibian Research and. Monitoring Initiative (both under the auspices of the U.S. Geological Survey). While many of these federal programs compliment state efforts, others simply use data collected by state frog surveys, assisting states in data acquisition, handling and analysis. These programs are summarized below.

Marsh Monitoring Program (MMP):

The Marsh Monitoring Program (MMP) contributes to the conservation of wetlands and wetland dependent wildlife in the Great Lakes region. The MMP was established by Bird Studies Canada and Environment Canada in 1994 and is intended to run well beyond the year 2000. The program was designed to provide information on marsh bird and selected amphibian populations, and to contribute to our understanding of their habitat needs. Along with the essential role played by MMP volunteers, the program receives important support from Environment Canada, the U.S. Great Lakes Protection Fund, the U.S. Environmental Protection Agency, and the Great Lakes 2000 Cleanup Fund. Forty-three Areas of Concern (AOCs) around the Great Lakes (7-8 in the LSW) have been identified as being stressed by pollutants, habitat loss, and habitat degradation and are in urgent need of rehabilitation. Although the scarcity of historical information on amphibian and marsh bird populations can make many interpretations of AOC recovery difficult, the MMP provides baseline information to help measure the success of these rehabilitation efforts and may help in suggesting improvements to restoration techniques. Although a special emphasis is placed on the monitoring of those Great Lakes coastal wetlands that are heavily polluted, information on marshes throughout the Great Lakes states and the province of Ontario is also very important to the success of the program. Over the long-term, information gathered by MMP volunteers can be used to track population trends of marsh birds, frogs and toads throughout the Great Lakes region.

Amphibian surveys use an "unlimited distance" semi-circular sampling area. This is because it is nearly impossible to accurately estimate distance in the dark in order to determine whether amphibians are calling from inside or outside a defined sample area. Amphibian stations should be separated by at least 500 meters (550 yards) in order to minimize the possibility that individuals or choruses are sampled twice. On routes established through the middle of a marsh, the semi-circular sample areas can be arranged back to back, so that stations face in opposite directions. This allows volunteers to fit in as many amphibian stations in a marsh as possible. Each amphibian survey route is visited on 3 nights, no less than 15 days apart, during the spring and early summer. Routes are surveyed in their entirety, in the same station sequence, starting at about the same time on all visits. The first visit should coincide with minimum night-time air temperatures of at least 5 C (41 F) and the first or second warm spring shower. Night-time air temperatures should be at least 10 C (50 F) for the second survey and 17 C (63 F) for the third survey. Each station is surveyed for 3 minutes and one of three Call Level Codes is used to categorize the intensity of calling activity for each species. In southern and central regions, surveys should begin one half hour after sunset and end before midnight. All surveys should be conducted in weather conducive to monitoring amphibians (i.e. on a warm, moist night with little or no wind).

Findings for the first 5 years are reviewed in Weeber and Vallianatos (2000). Amphibian surveys were run at least 15 times within the LSW during this period. It is premature to conduct trend analyses on these data, which must be separated from annual fluctuations to be meaningful. The MMP has estimated that to achieve a resolution of detecting an annual trend of 1% or less per year, 100 routes would have to be run for 11 years. Achieving this would require a substantial increase on the number of routes and volunteer effort in the LSW.

For more information see: http://www.bsc-eoc.org/mmpmain.html

North American Amphibian Monitoring Program:

The North American Amphibian Monitoring Program (NAAMP) is a collaborative effort among regional partners, such as state natural resource agencies and nonprofit organizations, and the U.S. Geological Survey (USGS) to monitor populations of vocal amphibians (http://www.mp2-pwrc.usgs.gov/NAAMP/). The USGS provides central coordination and database management. The regional partners recruit and train volunteer observers, to collect amphibian population data, following the protocol of the NAAMP. Amphibian population data are collected using a calling survey technique, in which observers identify local amphibian species by their unique vocalizations. Not all amphibian species make vocalizations, but many frogs and toads do. Observers are trained to identify their local species by these unique vocalizations or "frog calls." No data are publically accessible through NAAMP as of this writing, and the only routes listed for the region are 5 routes run in 2001 in Michigan. Currently no Canadian provinces are participating in the NAAMP calling survey. NAAMP may act as an umbrella organization for state frog calling programs, assisting in data analyses, with data being more accessible through states. U.S. coordinator contacts: MINNESOTA - Rich Baker, Minnesota Department of Natural Resources, 500 Lafayette Road, St. Paul, MN 55155-4040. Email: richard.baker@dnr.state.mn.us. Phone: (651) 297-3764. WISCONSIN - Mike Mossman and Lisa Hartman, Wisconsin Department of Natural Resources 1350 Femrite Dr. Monona, WI 53716 phone: (608) 544-5501 / (608) 221-6346 Mike's email: mossmm@dnr.state.wi.us Lisa's email: hartml@dnr.state.wi.us. Also Bob Hay, Wisconsin Department of Natural Resources, Box 7921, Madison, WI 53707. Phone: (608) 267-0849. Email: hayr@dnr.state.wi.us. MICHIGAN - Lori Sargent, MDNR Wildlife Division, PO Box 30180, Lansing, MI 48909. Email: SargenL2@michigan.gov.

Frogwatch USA:

Frogwatch USA is an educational, long-term frog and toad monitoring program coordinated by the US Geological Survey's Patuxent Wildlife Research Center. Frogwatch USA recruits volunteers to complement other ongoing local, national, and global amphibian monitoring efforts. Frogwatch USA collects important information about frog and toad populations across the USA; promotes an appreciation for diversity of frogs and toads; fosters an understanding of the importance of wetlands within our changing landscapes; and provides an opportunity for children and adults to learn more about and establish a relationship with the natural world. Data (if available) can be viewed for a single site through a web interface.

A first season summary report provides the following. Frogwatch USA volunteers are monitoring more than 350 wetlands in 46 different states. These volunteers have thus far reported more than 700 nights of observation despite most participants hearing of the program well into the breeding season. Frogwatch USA volunteers are young people, farmers, homemakers, naturalists, scientists, and other interested people that represent a diversity of professions and backgrounds. Frogwatch USA has established partnerships with schools, scout troops, nature centers, state parks, national parks, and North American Amphibian Monitoring Program (NAAMP) state and regional coordinators. These groups are actively monitoring sites while Frogwatch USA will analyze the data submitted. While the data set from the 1999 season is incomplete, information was collected to establish base data sets for anuran populations at

individual wetlands, distributions of anuran populations, and yearly patterns of anuran breeding activity. The phenology data can be used in the planning of NAAMP routes in the next year. Future goals for Frogwatch USA include: Develop graphical and tabular displays of Frogwatch USA data. Increasing outreach efforts (create educational materials for children and adults, enter into partnerships with established educational groups). Expand and improve upon the current Internet presence. Develop a Web site of anuran vocalizations for volunteers. Expand upon the number of volunteers, states represented, partnerships (including being incorporated into the NAAMP), and the data collected. There are three possibilities for the future of the Frogwatch USA program: (1) to end, (2) to expand, or (3) to preserve the status quo of the program. Hopefully, the program will expand which would help to legitimize Frogwatch USA and aid in the effort of biological monitoring and education.

Frogwatch USA Coordinator, Amy Goodstine, National Wildlife Federation, 1400 16th Street, NW, Suite 501, Washington D.C. 20036. Phone: (202) 797-6891. Email: frogwatch@nwf.org. Web site: http://monitoring2.er.usgs.gov/frogwatch/.

The North American Reporting Center for Amphibian Malformations (NARCAM):

NARCAM tracks sightings of amphibian malformations in North America by using online submission forms (there is a technical form for biologists and a form for non-biologists). Access to geographic distribution of reports, as well as information on the types of malformations found and the species affected in each area, is available online. The mission of the NARCAM is to facilitate the transfer of information on malformed amphibians. By compiling information from both the public and the scientific community, NARCAM hopes to convey an accurate account of this phenomenon and accelerate its investigation. The Reporting Center is also designed to encourage further collaboration among scientists working to understand the cause(s) of amphibian malformations in the wild. Some results are given on the website, with 835 reports of malformations; Northern Leopard Frogs, Northern Green Frogs, and American Bullfrogs reported most often; and Minnesota, Vermont, New Hampshire, and Wisconsin reporting the most malformities. Contact: narcam@usgs.gov or call 1-800-238-9801.Website: http://www.npwrc.usgs.gov/narcam/

Amphibian Research and Monitoring Initiative (ARMI):

In 2000, the President of the United States and the Congress directed the Department of the Interior (DOI) agencies to develop a plan to initiate monitoring of trends in amphibian populations on DOI lands and conduct research into causes of declines. The DOI has stewardship responsibilities over vast land holdings in the United States, much of which is occupied by or is potential habitat for amphibians. The U.S. Geological Survey (USGS), the science and research bureau for DOI, was given lead responsibility for planning and organizing this program, named the Amphibian Research and Monitoring Initiative or ARMI, in cooperation with the National Park Service, Fish and Wildlife Service, and Bureau of Land Management. USGS is uniquely qualified to develop and provide scientific leadership for such an effort. It has a long history of employing research scientists who have pioneered studies on amphibian life history, sampling techniques, toxicology, and health-related issues, and it has responsibility on many natural resources monitoring programs at regional, national, and continuant scales.

ARMI has the following objectives: a) Initiate long-term monitoring to determine trends in amphibian populations; b) Conduct research into causes of amphibian declines and malformations; c) Make use of relevant expertise within USGS and DOI; d) Make the information available to cooperators, land managers, the scientific community, and the general public. Studies by USGS scientists will concentrate on DOI and other federal lands, but ARMI will provide the framework for incorporating data collected on non-federal lands to encourage participation by states, universities, and non-governmental organizations. The framework can be conceptualized as a pyramid with extensive and necessarily coarse measurements at many monitoring sites across the country (the base of the pyramid), mid-level efforts at a moderate number of sites to provide a regional perspective on the status of amphibians (the middle portions of the pyramid), and intensive research efforts at a relatively small number of index sites throughout the country (the top of the pyramid). Activities at the different levels of the framework are integrated by common databases and reporting; comparable protocols, analytical tools, training, and planning; research on causes of change, which at all levels is guided by monitoring results; and synthesis across ecological regions, scientific disciplines, and governmental and institutional boundaries. ARMI monitoring activities will be organized nationally among seven regions, involving several USGS science centers, herpetologists, and hydrologists. The extensive bottom tier of the pyramid will provide an opportunity for participation and synthesis of data collected on non-federal lands by a variety of programs (the North American Amphibian Monitoring Program, state National Heritage Programs, etc.), state governments, universities, and non-governmental organizations. More intensive monitoring will emphasize DOI lands (National Parks, National Wildlife Refuges, BLM lands) and will be coordinated by USGS scientists.

Research will occur at all levels of the hierarchical framework and will focus on two tasks: identifying causes for declines/malformations, and refining and developing new methods for monitoring. Studies will focus on a broad range of environmental stressors and contaminants as well as the interaction of biotic and abiotic factors that may affect declining amphibian populations. Specific hypotheses and research designs will be guided by the results of monitoring activities, and will include both field and laboratory investigations.

The USGS Patuxent Wildlife Research Center will develop and manage a centralized database for data collected under ARMI, including timely electronic transfer of information to cooperators, land managers, the scientific community and the interested public. It is hoped that this database will provide a forum for other researchers to share their findings, so that analyses can address trends in species throughout their distributions, not just on federal lands.

A permanent ARMI Steering Committee with representation from within and outside the federal government will provide oversight and regular review of all ARMI activities. This committee will help to ensure that ARMI is progressing satisfactorily toward achieving its stated goals and objectives, and that its products are timely, relevant, and useful in meeting the needs of land managers, scientists, and other stakeholders interested in the conservation of amphibian resources.

Other DOI agencies have resources to work on priority ARMI activities. The Fish and Wildlife Service has initiated a nationwide survey on 48 National Wildlife Refuges in 31 states for contaminants that may be inducing malformations in amphibians. The National Park Service

is working with USGS to conduct amphibian inventories in National Parks. Initial efforts are focused in parks that are part of PRIMENet (Parks Research and Intensive Monitoring of Ecosystems Network), a group of large parks with intensive air quality and UV radiation monitoring.

Contacts: National ARMI Coordinator - Daniel James, 703-648-4253, dan_james@usgs.gov; Northeast ARMI Region - Robin Jung, 301-497-5875, robin_jung@usgs.gov; Upper Mississippi River ARMI Region, Walter Sadinski, 608-783-7550x55, wsadinski@usgs.gov.

Terrestrial Salamander Monitoring Program:

The Terrestrial Salamander Monitoring Program was activated in 1997, and provides protocols and data handling for monitoring terrestrial salamanders. Contact: Sam Droege, Patuxent Wildlife Research Center, 2100 Beech Forest Drive, Laurel, MD 20708-4038. frog@usgs.gov.

Ontario Programs:

Bishop and Pettit (1992) review the status, conservation and monitoring of Canadian amphibians. Several programs underway include Ontario and the LSW.

- Ontario Herpetofaunal Atlas Project: The Ontario Herpetofaunal Atlas (OHS) project began in 1984 to consolidate existing information and gather new data on Ontario's amphibians and reptiles. The primary purpose of the OHS project is to produce detailed distribution maps of the province's amphibians and reptiles. Online distribution maps are available at: http://www.mnr.gov.on.ca/MNR/nhic/herps/ohs.html. Starting in 1984 volunteers recorded amphibian and reptile observations on printed cards which were returned to the compilers at the end of each field season. These records were then entered into a computer database (using Dbase initially, then Foxpro). Data collection has continued in this manner to the present. In order to complement records gathered by volunteers, an effort was made to compile historic distribution data on Ontario's amphibians and reptiles. Specimen records from museum and university collections in Ontario (e.g. ROM, NMC, University of Guelph) and elsewhere (e.g. University of Michigan) were entered into the OHS database. In addition, records were extracted from published (e.g. journal articles) and unpublished (e.g. theses, park and natural area inventory reports) literature. OHS volunteers were also asked to submit pre-1984 records as well as current sightings. All records in the OHS database have a UTM (Universal Trans Mercator) grid reference (NAD 27) associated with them, except for a very few old records with extremely vague locality information (e.g. "north shore of Lake Ontario" or "Georgian Bay"). UTM grid references are accurate either to a 10 X 10 km atlas square or to a specific location (accurate to 100 m), with a few records accurate to 1 km. Maps appearing on this web page were generated using ArcINFO from the OHS database. Records are mapped using three symbols: red square = records documented by a specimen, photograph, or taped vocalization; blue circle = sight or auditory records gathered since the OHS project began in 1984; green triangle = pre-1984 sight or auditory records assembled during the OHS project. Efforts have been made to verify the accuracy

of as many records as possible (e.g. by requesting additional details from the observer), but it should be kept in mind that many of the records are sight records contributed by casual naturalists, and a few may be in error. Records which we were unable to verify and were possibly in error (e.g. beyond known range limits) were omitted from the maps but retained in the database for possible future verification. Limited access to records in the Ontario Herpetofaunal Summary database is available for conservation, education, or research purposes by contacting Mike Oldham at the Natural Heritage Information Centre (michael.oldham@mnr.gov.on.ca). Note that precise locality information on some rare species will only be released under special circumstances and that a fee may be charged for complicated or time-consuming database searches. The Natural Heritage Information Centre (NHIC) welcomes additional records of Ontario amphibians and reptiles for incorporation into the OHS database. Particularly useful are records of rare species and records from poorly covered areas, but any records (current or historic) of Ontario amphibians and reptiles will be accepted. Future plans include the ability to electronically enter and submit records, distribution maps linked live to the OHS database so that they will be updated as soon as new records are added, photographs of Ontario species, ability to search the OHS database on the web, and other enhancements. Citation: Oldham, M.J. and W.F. Weller. 2000. Ontario Herpetofaunal Atlas. Natural Heritage Information Centre, Ontario Ministry of Natural Resources. http://www.mnr.gov.on.ca/MNR/nhic/herps/ohs.html (updated 15-01-2001).

- The Natural Heritage Information Centre (NHIC) compiles, maintains and provides information on rare, threatened and endangered species and spaces in Ontario. This information is stored in a central repository containing a computerized database, map files and an information library, which are accessible for conservation applications, land use planning, park management, etc. The NHIC was established in 1993 as a joint venture between the Ministry of Natural Resources (MNR) and three partners: The Nature Conservancy of Canada, Natural Heritage League and The Nature Conservancy. The centre is now part of the Science and Information Branch of the MNR and is located in Peterborough, Ontario, Canada. The goal is to generate a permanent and dynamic atlas and data bank on the character, distribution and conservation status of natural areas, critical flora and fauna, communities and special features in Ontario. Objectives are: a) to assemble and organize information on endangered species and spaces from all available sources, such as atlas projects, naturalist groups, universities, museums, and inventory/monitoring programs by public and private sector agencies and organizations; b) to make information on endangered species and spaces more accessible for ecologically-sound land use planning, and in support of biodiversity protection programs; c) to track priority species, ecological communities and sites to guide biodiversity conservation activities by public and private sector conservation organizations; d) to maintain a central repository of natural heritage data and information in Ontario.
- Frogwatch Canada. The National Frogwatch program is supported by Environment Canada's Ecological Monitoring and Assessment Network (EMAN). Working with the Canadian Nature Federation and provincial and territorial co-ordinators, Frogwatch encourages participants to learn about the environment while helping to gather the

information needed to protect it. By monitoring a site several nights over the calling season, Frogwatch participants can help scientists discover what frogs are calling where, and more importantly, if they're still calling there next year. Website: http://www.cnf.ca/frog/id.html. Ontario FrogWatch Co-ordinator: Sarah Ingwerson, Frogwatch Ontario, c/o Adopt-A-Pond, Toronto Zoo, 361A Old Finch Ave., Scarborough, ON M1B 5K7. Phone: (416) 392-5999. E-mail: aap@zoo.metrotor.on.ca

- Canadian Wildlife Federation Amphibian Call Counts (Backyard Survey): The goal of this initiative is to determine the causes of amphibian population fluctuations, while educating and involving the public in frog and toad monitoring. Participants monitor frog and toad calls, relative density of calling, time, and temperature on a nightly basis in their backyards. Scope is throughout Ontario. Contact: Christine Bishop, Amphibian Survey, Canadian Wildlife Service, Environment Canada, 867 Lakeshore Rd., Box 5050, Burlington, Ont. L7R 4A6. Tel.: (905) 336-4968. Web site: http://www.cwf-fcf.org/surveys/survey02.htm
- Canadian Wildlife Federation Amphibian Call Counts (Roadside Survey): The goal of this initiative is to determine the causes of amphibian population fluctuations, while educating and involving the public in frog and toad monitoring. Participants drive along quiet roads in one direction, stopping 10 times at intervals of 0.8 km for a total of 7.2 km. Contact: Christine Bishop, Amphibian Survey, Canadian Wildlife Service, Environment Canada, 867 Lakeshore Rd., Box 5050, Burlington, Ont. L7R 4A6. Tel.: (905) 336-4968. Web site: http://www.cwf-fcf.org/surveys/survey03.htm

Michigan Programs:

- Michigan Frog Survey. Now in its seventh year, the Michigan Frog and Toad Survey was initiated in 1988 on a limited basis to increase knowledge of anuran abundance and distribution, and to monitor populations over the long term. Over the next few years, a statewide system of permanent survey routes is planned. Each route will consist of ten wetland sites which will be visited three times annually, in early spring, late spring, and summer, by volunteer observers. Observer identify the species present on the basis of calls and make a simple estimate of abundance for each species, using a call index value of 1, 2, or 3. Miscellaneous observations are also recorded from locations other than the permanent survey routes. To date, there are more than 400 routes statewide, running through every Michigan county. This survey is modeled after the Wisconsin Frog and Toad Survey, which was begun in 1981. Contact: Michigan Frog and Toad Survey, Wildlife Div, Dept Natural Resources, Stevens T Mason Bldg, PO Box 30180, Lansing, MI 48909-7528 USA.
- Michigan Natural Features Inventory. MNFI maintains a continuously updated information base, the only comprehensive, single source of data on Michigan's endangered, threatened, or special concern plant and animal species, natural communities, and other natural features. MNFI has responsibility for inventorying and tracking the State's rarest species and exceptional examples of the whole array of natural communities. MNFI also provides information to land managers for many types of permit applications regarding these elements of diversity. The MNFI information base consists

of over 11,000 site-specific records of occurrences of all elements tracked by the program. These records are mapped on USGS topographic maps and incorporated into the Biological and Conservation Database (BCD), a database developed by The Nature Conservancy and now in use in most of the United States and many other countries, especially in the western hemisphere. Records are also periodically incorporated into the Michigan Resource Information System (MIRIS) and Coastal and Inland Waterways Program Information System (CIWPIS), programs of the MDNR. MNFI has developed geographic information systems (GIS) capabilities and anticipates the day when the database will be routinely available in GIS format. In addition to site-specific records, BCD and MNFI manual files contain a great deal of compiled information on biology, distribution, threats, status, and trends of the species and communities tracked by the program. The records in the MNFI information base were gathered from museum and herbaria records, published and verified unpublished accounts, from field work by MNFI staff, and from private consultants and knowledgeable individuals. The MNFI database attributes each record to the person who submitted it. MNFI requires its staff and contractors to obtain permission to enter private land and does not condone trespass by anyone who might submit data to the database. The inventory process is not complete for all areas of the state. Many areas have not yet been specifically or thoroughly surveyed for natural features. Further, populations of plants, animals, and communities are constantly changing and require site revisits to verify continued presence or absence. Therefore, absence of known records in the MNFI database should not be taken as a definitive statement on lack of occurrence of natural features at a site. In some cases the only way to obtain a definitive statement on the current status of natural features is to have a competent biologist perform a complete field survey. The distribution across the state of thorough MNFI inventories has been influenced partly by priorities based on relative threats, rarity or fragility of sites or elements, and partly by funding sources. Many areas of the state likely to have significant natural features have not been inventoried by MNFI due to lack of adequate funds. The BCD is used to manage site-specific information on plant and animal species and natural communities being tracked by MNFI. An element occurrence record (EOR), found in the BCD, is a record which includes population and community data, environmental features associated with the species or community, and precise geographical data including township, range, latitude-longitude, county, watershed, and land management/ownership status. The best source for additional information is also cited. Information entered into the BCD follows Natural Heritage Methodology. MNFI personnel can be contacted through their website at http://www.msue.msu.edu/mnfi/.

Minnesota:

- Minnesota Natural Heritage Program: The Natural Heritage Information System (NHIS) provides information on Minnesota's rare plants, animals, native plant communities, and other rare features. The NHIS is continually updated as new information becomes available, and is the most complete source of data on Minnesota's rare or otherwise significant species, natural communities, and other natural features. Its purpose is to

foster better understanding and conservation of these features. The most commonly-used component of the system is the Rare Features Database. The Database began as a compilation of historical records from museum collections and published information. This has been supplemented with data from years of field work on Minnesota's rare features. Since 1986, our knowledge of Minnesota's rare features has increased substantially with the progress of the Minnesota County Biological Survey. The Rare Features Database comprises locational records of Rare animals. All animal species that are listed as Federally endangered or threatened (except the gray wolf) are tracked, as well as all birds, small mammals, reptiles, amphibians, mussels, and butterflies that are listed as State endangered, threatened or special concern. Because information is not based on a comprehensive inventory, there are rare or otherwise significant natural features in the state that are not represented in the database. A county-by-county survey of rare natural features is now underway, and has been completed for some counties. Our information about natural communities is, therefore, quite thorough for those counties. However, because survey work for rare plants and animals is less exhaustive, and because there has not been an on-site survey of all areas of each county, ecologically significant features may exist for which we have no records. Information from the Rare Features Database can be provided for review of land-use plans, impacts of specific development projects, research projects, and for other legitimate uses. The publication of exact location information, however, may threaten the continued existence of some rare species. For example, some endangered wildflowers, such as orchids, have very attractive blooms that can lead to exploitation by collectors. Some rare animal species, such as the bald eagle, are sensitive to disturbance by humans, and may desert a breeding area that is approached too closely during certain portions of the breeding season. For this reason, program staff must carefully screen all requests, and may ask that the level of detail in publication of location information be modified, or that interpretation of data be reviewed by program staff. Contact: Bonita Eliason, Supervisor, 500 Lafayette Road, St. Paul, MN 55155-4025. Email - bonita.eliason@dnr.state.mn.us, tel - (651) 297-2276, fax - (651) 296-1811.

- Minnesota Herpetology: This web site by Jeff LeClere covers the herpetology of Minnesota, with detailed species accounts. Contact: email - REPTILIA74@aol.com. Web: http://207.36.67.48/Minnesota-Herpetology/index.html.
- Minnesota Herpetological Society: Founded in 1981, the MHS is a nonprofit organization associated with the Bell Museum of Natural History. The aims and goals of the society include: to further the education of the membership and the general public in care and captive propagation of reptiles and amphibians, to promote the study and conservation of reptiles and amphibians, and to educate the membership and the general public in the ecological role of reptiles and amphibians. Recently, forays have been organized to survey for herps in cooperation with the Minnesota County Biological Survey. Members receive a monthly newsletter, and use of the MHS library. Contact: The Minnesota Herpetological Society, c/o The Bell Museum of Natural History, 10 Church Street SE, Minneapolis, MN 55455-0104.
- Minnesota Frog and Toad Calling Survey: The Minnesota Frog and Toad Calling Survey

is run cooperatively by the Minnesota DNR and 1000 Friends of Frogs at Hamline University, St Paul. Volunteer participants are assigned pre-selected routes and asked to conduct nighttime listening surveys. Each route consists of ten wetland (breeding) sites, which are visited three times annually (early spring, late spring, and summer) between May and July. At each site, the observer identifies the species present on the basis of breeding season calls and makes a simple estimate of the abundance of each species using call index values of 1, 2, or 3. This protocol is based on the North American Amphibian Monitoring Program (http://www.im.nbs.gov/amphibs.html). Approximately 25 routes fall within the LSW. The pilot program which preceded the survey is reviewed in Moriarty (1997). Contact: Heather Schoonover at Thousand Friends of Frogs, Hamline University, St. Paul, 651-523-2945, or e-mail at hschoonover@gw.hamline.edu.

- Minnesota County Biological Survey: The Minnesota County Biological Survey began in 1987 as a systematic survey of rare biological features. The goal of the Survey is to identify significant natural areas and to collect and interpret data on the distribution and ecology of rare plants, rare animals, and native plant communities. To date MCBS has completed work in 50 of Minnesota's 87 counties, and added over 12,800 new records of rare plant and animals to the Rare Features Database, Natural Heritage Information System (NHIS). Recent systematic inventories have included herps in the LSW (Casper, 1999). Maps of natural communities and rare species for all Minnesota Counties in the LSW will eventually be published. Contact: Carmen Converse, Supervisor, Minnesota County Biological Survey, 500 Lafayette Rd Box 25, St Paul, MN 55155-4025. Tel. (651) 296-9782, email: carmen.converse@dnr.state.mn.us, website: http://www.dnr.state.mn.us/ecological_services/mcbs/index.html

Wisconsin:

- Wisconsin Frog and Toad Survey: The Wisconsin Frog and Toad Survey (WFTS) is a volunteer program coordinated by the Wisconsin Department of Natural Resources, in cooperation with the U.S. Geological Survey and the North American Amphibian Monitoring Program. The WFTS was initiated in 1981 to help determine the status and population trends of Wisconsin's 12 species of frogs and toads. Survey data are collected annually by cooperators who note the distinctive calls of each species along permanent roadside routes. It is the longest running anuran calling survey in the North America, and a trend analysis was published in 1998 (Mossman et al., 1998). Most species are sampled well enough (statewide) to detect a 3% mean annual change over 20 years. Long-term declining trends are noted for Spring Peepers, Northern Leopard Frogs, Cope's Gray Treefrogs, and possibly Pickerel Frogs. An online web site provides background information and allows the user to view species maps and conduct trend analyses. For more information see: http://www.mbr-pwrc.usgs.gov/wifrog/frog.htm#tableofcontents.
- Wisconsin Herpetological Atlas Project: The Herp Atlas tracks the distributions of amphibians and reptiles in Wisconsin. The Herp Atlas was initiated in 1986 by the Vertebrate Zoology Section of the Milwaukee Public Museum, with the cooperative support of the Natural Heritage Inventory Program (Bureau of Endangered Resources, Wisconsin Department of Natural Resources; and the Nature Conservancy, Wisconsin

Chapter). The Herp Atlas has produced a computerized database of amphibian and reptile distribution, based on records obtained from museum collections, field surveys, literature, and field notes provided by volunteer observers throughout the state. Generalized distribution maps are maintained on the web site. The data collected helps to map species distributions, document rare species occurrences, examine habitat requirements, and plan conservation priorities. Future plans are for web access to mapping, and print publications. For further information contact the project head: Gary S Casper, Section of Vertebrate Zoology, Milwaukee Public Museum, Milwaukee, WI 53233. (414)278-2766. Fax (414)278-6100. E-mail gsc@mpm.edu. Web site: http://www.mpm.edu/collect/vertzo/herp/atlas/atlas.html.

Research and Resource Review

Research on amphibians and reptiles in the region has a long history, and is ongoing through universities, museums, and federal and state/provincial agencies. Much research is the result of independent interests of academic investigators, and this body of science is best gleaned from the literature. This approach to research is individual based, and continues only so long as the individual researchers remain interested in the region and funded. Less accessible are government reports. Some starting points for government reports are: U.S. Geological Survey, Biological Research Division; U.S. National Park Service; U.S. Environmental Protection Agency; Environment Canada; The Great Lakes Commission; and state and provincial natural resources departments. Some specific projects and resources are given below.

Reptile and Amphibian Toxicology Literature (RATL):

The RATL database was compiled by the Canadian Wildlife Service to provide access to the published literature on amphibian and reptile toxicology. Data resulting from earlier published research on the effects of environmental contaminants on amphibians were tabulated and assessed in a Canadian Wildlife Service report published in 1989 (Harfenist A., T. Power, K.L. Clark and D.B. Peakall. 1989. A Review and Evaluation of the Amphibian Toxicological Literature. Technical Report Series No. 61. Canadian Wildlife Service, Headquarters). A recent update of this publication was compiled as a static subset of the information available in the RATL database. The database can be searched by contaminant group, common name, trade name or CAS number; by species, genus, or higher taxonomic group; by author; or by certain toxicological effects categories or any combination of these criteria. At present, the RATL database contains approximately 6200 contaminant-related studies, divided almost equally between reptiles and amphibians. Approximately 650 different species are listed in the database and 380 species have contaminant data for them. At present, 72% of the species with contaminant data are amphibians. The database contains information from as early as 1926 and represents studies from 48 different countries. Of the field studies where the country was reported, 60% were done in the United States while 17% of the sites were in Canada (74% in Ontario, 16% in Quebec, 5% in British Columbia). Approximately 1300 of the studies contain tissue residue concentrations, 65% of which pertain to reptiles. Approximately 700 studies contain acute toxicology data, almost all of which pertain to amphibians. There are 820 different contaminants listed in the database. Of the classes of contaminants studied, pesticides account for

the majority of studies (43%) and insecticides account for 57% of the studies conducted with pesticides. The RATL database also includes studies on metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), radiation studies and altered acidity studies, amongst others.

Project Manager: Bruce Pauli, National Wildlife Research Centre, Canadian Wildlife Service, 100 Gamelin Blvd., Hull, Quebec K1A-0H3. Email: bruce.pauli@ec.gc.ca. Web site: http://www.cws-scf.ec.gc.ca/nwrc/ratl/index_e.htm

AmphibiaWeb:

AmphibiaWeb is an online system enabling anyone with a Web browser to quickly search and retrieve information relating to amphibian biology and conservation. The goal is to establish a "home page" for every species of amphibian in the world (estimated to be close to 5,000 species). AmphibiaWeb already offers ready access to taxonomic information for every recognized species of amphibian in the world. Species accounts are being added regularly by specialists and volunteers and they contain species descriptions, life history information, conservation status, literature references, photos and range maps for many species. Some species have complete accounts; others as yet have only photographs or maps. But all species can be queried for taxonomic, distributional and exact specimen data. AmphibiaWeb also provides easy and fast access to museum specimen data including the large herpetological collections of the Museum of Vertebrate Zoology, the California Academy of Sciences, the Field Museum of Natural History, and the Museum of Comparative Zoology. AmphibiaWeb currently (May 20, 2002) contains 5,403 species, with approximately 805 species accounts, 1153 distribution maps, 2594 literature references, and 1633 photos of 525 different amphibian species. AmphibiaWeb has been created in conjunction with the Digital Library Project at the University of California, Berkeley, which hosts this Web site and developed the technology used for viewing species information and photos. Citation: AmphibiaWeb: Information on amphibian biology and conservation. [web application]. 2002. Berkeley, California: AmphibiaWeb. Available: http://amphibiaweb.org/. (Accessed: 2002).

Amphibian Count Database:

Sample size has a lot to do with whether or not a monitoring program will detect population trends (should they exist) over time. Variance in counts of animals over space and time is the major determinant of how many samples are needed for a program to be effective. Obtaining a good estimate of variability for a particular species at a given place under a given sampling regime requires several years of pilot study data. Short of that, one might cast around for estimates from other studies for a rough place to start (with plans to refine your protocol once your data is in). That is the idea behind this database: to organize what is already known from the literature. The goal for this database is straightforward: compile counts of amphibians over time from published studies, and calculate descriptive statistics such as mean, standard deviation, and coefficient of variation. To date, a total of 48 studies has yielded 213 separate count series for 55 amphibian species. Website: http://www.mp2-pwrc.usgs.gov/ampCV/ampdb.cfm

Amphibian Research and Monitoring Initiative (ARMI):

See description in Monitoring Section.

Great Lakes Information Network (GLIN):

The Great Lakes Information Network (GLIN) is a partnership that provides one place online for people to find information relating to the binational Great Lakes-St. Lawrence region of North America. GLIN offers a wealth of data and information about the region's environment, economy, tourism, education and more. Thanks to its strong network of state, provincial, federal and regional partner agencies and organizations, GLIN has become a necessary component of informed decision making, and a trusted and reliable source of information for those who live, work or have an interest in the Great Lakes region. Web site: http://www.great-lakes.net/

The Nature Conservancy Great Lakes Program:

The Nature Conservancy recently completed a Herp Conservation Workshop for their Great Lakes Program. The Great Lakes Program focuses on four major areas to protect the biological diversity of the Great Lakes ecoregion: 1) Science to Guide Action - Advancing scientific research and pilot projects that expand our understanding of the ecological threads that tie together the Great Lakes Ecosystem. 2) Eliminating Threats to Biodiversity - Identifying threats to Great Lakes biodiversity and developing strategic solutions to reduce or eliminate those threats. 3) Strategic Partnerships - Improving the Great Lakes conservation community's ability to integrate biodiversity conservation with economic, social, and organizational goals. 4) International Conservation - Protecting the diversity of life throughout the entire Great Lakes ecosystem by collaborating with Canadian partners. A report, *Protecting Amphibians and Reptiles in the Great Lakes Region: Identifying Important Areas for Conservation Action*, includes the U.S. portion of LSW, and identifies threats to amphibians and reptiles, as well as a list of sites important for amphibians and reptiles which are recommended for protection. Contact: The Nature Conservancy, Great Lakes Program, 8 S. Michigan Ave., Suite 2301, Chicago, IL 60603. Phone: 312-759-8017. Web Site: http://nature.org/aboutus/projects/greatlakes/

The Federation of Ontario Naturalists (FON):

The FON protects Ontario's nature through research, education, and conservation action. FON champions woodlands, wetlands and wildlife, and preserves essential habitat through its own system of nature reserves. FON is a charitable organization representing 25,000 members and supporters and 119 member groups across Ontario. Web site: http://www.ontarionature.org/

National Wildlife Federation Great Lakes Field Office:

The Great Lakes Field Office in Ann Arbor, Michigan, unites people throughout the eight-state Great Lakes region, the U.S. and Canada to protect the world's greatest freshwater seas, the surrounding ecosystem, and the benefits they provide to people and wildlife. Contact: Great Lakes Field Office, National Wildlife Federation, 213 W. Liberty, Suite 200, Ann Arbor, MI 48104-1398. Web site: greatlakes@nwf.org. Phone: 734-769-3351.

The Long Term Ecological Research (LTER) Network:

The LTER is a collaborative effort involving more than 1100 scientists and students investigating ecological processes over long temporal and broad spatial scales. The Network promotes synthesis and comparative research across sites and ecosystems and among other related national and international research programs. The mission of the LTER Network: a) Understanding ecological phenomena over long temporal and large spatial scales; b) Creating a legacy of well-designed and documented long-term experiments and observations for future generations; c) Conducting major synthetic and theoretical efforts; and d) Providing information for the identification and solution of ecological problems. Core research areas are: a) Pattern and control of primary production; b) Spatial and temporal distribution of populations selected to represent trophic structures; c) Pattern and control of organic matter accumulation and decomposition in surface layers and sediments; d) Patterns of inorganic inputs and movements of nutrients through soils, groundwater and surface waters; and e) Patterns and frequency of disturbances. One station in the network is within the LSW: University of Wisconsin Trout Lake Station in Vilas County, Wisconsin.

Organization of Biological Field Stations (OBFS):

OBFS is an association of about 180 field stations and professionals concerned with field facilities for biological research and education, primarily in North America and Central America. Seven stations are located in the LSW:

Cloquet Forestry Center in Cloquet, Minnesota.
ACM Wilderness Field Station near Ely, Minnesota.
St. Croix Watershed Research Station near Marine on St. Croix, Minnesota.
Kemp Natural Resources Station near Woodruff, Wisconsin.
Treehaven Field Station near Tomahawk, Wisconsin.
University of Wisconsin Trout Lake Station in Vilas County, Wisconsin.
University of Notre Dame Environmental Research Center, Land O'Lakes, Wisconsin.

IUCN/SSC Declining Amphibian Populations Task Force (DAPTF):

The DAPTF is devoted to investigating the worldwide decline in amphibian populations. DAPTF publishes the newsletter FROGLOG. Regional working groups promote research and education, and act as information clearing houses. The Great Lakes Declining Amphibians Working Group is a Regional Working Group of DAPTF, and encompasses the states of Minnesota, Wisconsin and Michigan. Contact: Gary S Casper, Milwaukee Public Museum, 800 W Wells St, Milwaukee, WI 53233. USA. Tel: 414-278-2766. Email: gsc@mpm.edu. Web Site: http://www.mpm.edu/collect/vertzo/herp/Daptf/daptf.html.

Partners in Amphibian and Reptile Conservation (PARC):

PARC is a new multi-sector partnership dedicated to the conservation of the herpetofauna–amphibians and reptiles--and their habitats. PARC was formed in 1998 to address these needs and to find solutions. PARC Mission: To conserve amphibians, reptiles and their habitats as integral parts of our ecosystem and culture through proactive and coordinated public/private partnerships. A Midwest Working Group includes the LSW. The key to PARC's success will be the inclusion of all individuals, organizations, and agencies with an interest in amphibian and reptile conservation. PARC is not a funding organization or a policy maker.

PARC will increase communication and cooperation among many diverse groups who are interested in the conservation of reptiles and amphibians. PARC will enable each and every person and group involved to become more aware of national and regional issues confronting amphibians and reptiles. PARC also will give individuals a better idea of how their agency or organization can contribute to conservation of herpetofauna and their habitats. The diversity of participants makes PARC the most comprehensive conservation effort ever undertaken for amphibians and reptiles. Web Site: www.parcplace.org.

Recommendations

The Lake Superior Watershed is a spectacular region of vast and beautiful expanses of forests, lakes and streams. It also has a long history of tremendous abuse, beginning with the "Big Cut", an unprecedented rampage of logging that destroyed nearly all of the old growth forests of the region about a century ago. This was followed by intense fires, failed agriculture, collapse of the fisheries from over harvest, intensive mining operations for iron ore, large scale wetland losses and shoreline development, and input of a toxic legacy of chemical contaminants via municipal sewage and industrial effluents. Today, waters and soils in the region are laced with hormone disrupting chemicals, cancerous asbestos and PCBs, and toxic mercury. Acid rain and mercury deposition continues, as do wetland losses, shoreline development and building sprawl, and intensive timber harvest. Recently, new threats are advancing in the form of often destructive recreational activities (off road vehicles in particular), proliferation of invasive species, and global warming. Global warming threats are particularly dire for amphibians, with a predicted warmer and drier climate. Finally, the prospect of diverting Great Lakes water to the central plains states, which have already depleted their own aquifers and lobbied hard for draining the Great Lakes, will loom ever more ominous as global warming progresses.

Within this background, conserving amphibians and reptiles will be challenging. Our goal should be to keep common species common. Perhaps the most enduring blow to amphibians came from the initial deforestation. It is estimated that salamander populations require 30-60 years to recover from a clear cut (Petranka, 1998) - and that is assuming the forest is allowed to regenerate. Today this phenomena is easily observed by comparing amphibian abundance in intensively managed forests with the few remaining old growth stands. The latter provide cooler, moister environments with better microhabitat structure and food resources, resulting from thicker duff and more downed woody debris. It is therefore likely that the "Big Cut", and a continuing practice of intensive forest harvest since, has resulted in a significant depression of amphibian abundance, and permanent loss of unique genetic resources from the region. Perhaps entire species, never known to science, have already been lost. Compounding problems for amphibians are continuing losses of breeding habitat (especially isolated wetlands), and pervasive chemical contaminants in the environment. Negative correlations between amphibian abundance and breeding success, and altered pH and chemical contaminant levels, abound.

Reptiles in the region have perhaps fared better, in that few are forest interior residents, thus escaping many problems associated with deforestation and intensive management. Species specific problems for reptiles are numerous, however, and their distribution, abundance, life history and ecology is less well known than amphibians.

Information needs for amphibians and reptiles in the LSW have already been identified

by the TWCC as:

1. Development of, and cross-agency agreements to adhere to, standard monitoring protocols for amphibian and reptile surveys.
2. Implementation of more routes and surveys for all amphibian and reptile monitoring programs in the Lake Superior basin, especially for reptile species.
3. Compilation of existing information on all amphibian and reptile species for the Lake Superior basin.
4. Identifying reasons for population changes for amphibians and reptiles.
5. Identifying appropriate conservation and management practices for amphibians and reptiles in the region.

This report moves forward items 3 and 5, but real progress on all goals must come from dedicated, funded initiatives. Suggestions for projects and implementation are given below.

Inventory and Monitoring Recommendations:

Inventory and monitoring efforts are currently scattered across many agencies, often without common standards. A national monitoring strategy has been proposed for Canada (Bishop and Pettit, 1992) which could be emulated throughout the LSW. Inventory is well along in the LSW, but work remains. Several species reach their range limits within the LSW, and necessarily become rare at these limits, making detection more difficult, and more desirable for investigating and addressing conservation genetics. Inventory needs vary by region and species, and are often best put into effect by local resource managers, by reviewing existing knowledge for specific sites and/or species and addressing gaps through additional field work. Of special interest are inventories of island faunas, which might identify unique genetic resources, and reveal aspects of ecology and biogeography important to conservation and management (see Hecnar, et al., in press). This review identifies resources for managers to begin inventory reviews for their regions, such as that recently performed by the Apostle Islands National Lakeshore (Casper, 2001a-b). Since these inventories often involve extensive data acquisition and transformation, and detailed data interpretations coupled with field work, the use of regionally experienced herpetologists is recommended for best results. Inventory methods will vary by target species.

The most widespread monitoring technique for amphibians is the use of anuran calling surveys. These data can be useful in detecting long term trends, but are limited in the number of species that can be tracked, and require a large and dedicated volunteer work force. In the LSW, large regions lack sufficient volunteer resources (mainly due to low human population density). Greater consolidation of volunteer survey coordination may be more effective. Most programs now follow the Wisconsin standard protocol (Mossman et al., 1998). Standards for data analyses are also being developed. See the discussion on Power Analysis of Monitoring Programs at http://www.mp1-pwrc.usgs.gov/powcase/index.html, which includes online bibliographies and in-depth analyses of study designs and sample size requirements. Cooperation among various anuran calling surveys across the LSW is recommended, with goals set for levels of trend detection and sufficient aggregate sample sizes to achieve this. In the LSW, the only species likely to be adequately sampled by call survey methods are: Eastern American Toads, Western Chorus Frogs, Boreal Chorus Frogs, Northern Spring Peepers, Eastern Gray Treefrogs, Cope's Gray Treefrogs, Northern Green Frogs, and Northern Leopard Frogs. Species within the LSW which may be difficult to monitor via calling surveys because of rareness or practical difficulties

(poor carrying power of calls, short breeding seasons, unpredictable breeding periods) are: Wood Frogs, Pickerel Frogs, Mink Frogs, and American Bullfrogs.

Other amphibian survey techniques are discussed in Heyer et al. (1994) and others. Terrestrial salamanders can be sampled by a variety of time and effort constrained techniques, including visual searches, aquatic trapping, or drift fence/pitfall arrays at breeding sites. The aquatic Mudpuppy can be trapped by baited aquatic traps. Visual search methods for nesting Four-toed Salamanders have been developed by Casper (1996a-b, 1999, 2000) and successfully applied in Minnesota and Wisconsin (Casper, op cite). These methods are fairly time intensive, can be potentially destructive of micro-habitats, and are not suited for volunteer programs. Therefore, a system of intensive sampling is recommended in the LSW for non-calling amphibians, using a variety of quantitative techniques, to be repeated at intervals sufficient to detect trends in the desired time frame.

Both effort towards, and standardization of techniques for, reptile inventory and monitoring trails behind that for amphibians. The Smithsonian Institution Press is currently working on a publication *Measuring and Monitoring Biological Diversity: Standard Methods for Reptiles*, under the authorship of Dr. Roy McDiarmid. Meanwhile, various trapping and visual search techniques are in use and described in the literature. These practical difficulties should in no way diminish the importance of obtaining inventory and monitoring data for reptiles, however. In the LSW, reptiles may be in more urgent need of conservation measures than are amphibians, although the paucity of data make this difficult to evaluate. Nevertheless, more reptiles than amphibians are listed as special concern or threatened in the region (Table 1), and Wood Turtles, Blanding's Turtles and many snakes are thought to be declining.

<u>Suggested Inventory Needs in the LSW</u>:

- Reference Sites: Perhaps the most critical pan-basin need is the designation of a system of bioreserves to act as reference sites for long term ecological research, inventory and monitoring. These sites should capture existing ecosystems of the LSW, be in a natural condition (i.e. relatively intact pre-settlement communities), and be secure from future threats (as much as possible). Such sites fall under the recommendation for "intensive monitoring sites" by Bishop and Pettit (1992). Only by having such reference sites can conditions in more altered communities (the rest of the watershed) be judged. The lack of a system of reference site reserves has been a consistent handicap to *all* ecological research within the region, in that community health is exceedingly difficult to judge without knowing what a natural system is supposed to be like. The LSW is still relatively pristine, and therefore one of the few regions in North America where a system of bioreserve reference sites can still be implemented. This should be a top multi-disciplinary, pan-agency, priority. A suggested starting point for establishing these reference sites is to develop a mission and goals statement with stakeholders, and invite existing state, provincial and national parks, the Long Term Ecological Research Network, the Organization of Biological Field Stations, the Federation of Ontario Naturalists, the National Wildfire Federation Great Lakes Field Office, and The Nature Conservancy Great Lakes Program, to participate (see Research and Resources section).
- Mudpuppies: Because of suspected declines due to lampricide programs and other

environmental contaminants, there is an urgent need for baseline distribution data on Mudpuppies in the LSW, upon which monitoring and research programs can be built.

- Unisexual Ambystomid Salamanders: The distribution of unisexual salamanders of the *Ambystoma laterale-jeffersonianum* complex is poorly known. Additional sampling, with appropriate techniques for identifying polyploids, is recommended.
- Four-toed Salamanders: With the recent discovery that the range of the Four-toed Salamander extends further west than previously thought, additional inventory work is warranted to define these range limits, which fall within the northwestern portion of the LSW. This species is thought to be a glacial relict, with spotty and discontinuous distribution in disjunct habitats of moist, mature forest, and is especially sensitive to intensive forestry practices, arguing further for a complete inventory.
- Frog Inventories: Anurans are tracked by a number of existing frog and toad calling surveys. Additional routes might be warranted in regions where these programs fail to reach (north shore region especially), but should be incorporated into existing programs for efficient data handling. Of special interest is defining the range limits of Boreal and Western Chorus Frogs in the southern LSW, and where they hybridize. Relative distributions of *Hyla versicolor* and *Hyla chrysoscelis* also need clarification.
- Wood Turtles: Because of widespread declines, sensitivity to recreational disturbance and logging, threatened status, and relatively large and complex habitat requirements, remaining populations of Wood Turtles in the LSW should be inventoried preliminary to implementing conservation and recovery efforts.
- Other Turtles: Further inventories targeting the rarer turtles in the region would be useful, to identify existing populations and range limits preliminary to developing research and management programs. Suggested target species are: Blanding's Turtle (throughout the southern LSW, concentrating on gaps between existing records and range limits); Northern Map Turtle (re-confirm the Swan lake, Michigan record, and further investigate the Namekagon and St. Croix rivers watersheds in Minnesota and Wisconsin); Eastern Spiny Softshell (southwestern portion of the LSW, concentrating on gaps between existing records and range limits).
- Five-lined Skinks: The status of Five-lined Skinks in Michigan's Upper Peninsula warrants investigation, starting with an inventory.
- Snakes: Apparently rare snakes that warrant further inventory in the LSW are: Dekay's Brownsnake, Bullsnake, Eastern Hog-nosed Snake, Eastern Milksnake, and Northern Ring-necked Snake. Inventories should concentrate on gaps between existing records and range limits. This type of inventory would best fit under the "extensive monitoring site" concept in Bishop and Pettit (1992), at least initially. Intensive monitoring work may follow after inventory is finished.
- Atlassing: Atlas projects act as central repositories for herp distribution data, and greatly enhance the ability of land managers and researchers to compile species lists and coarsely evaluate status and needs from one data source. Currently, only Wisconsin and Ontario have dedicated herp atlasses within the LSW. However, all states and provinces are developing Natural Heritage Inventories, which have a much larger scope and hence a smaller emphasis on herps. These data repositories require large investments in acquiring

and digitizing data, georeferencing data, verifying data, maintaining databases and equipment, making data available for use, keeping data current, and maintaining partnerships with cooperators. The current model for development of atlasses is state/provincial based, usually partnering with an academic institution. This model is probably the most likely to succeed, as successful data acquisition and verification depends heavily on local cooperators and users. Therefore, it is recommended that atlassing projects retain the state/province based model, be assisted and encouraged through funding opportunities from users, continue to operate as partnerships with formal data sharing models, and make data available through web based interfaces to the degree practical and desirable.

- Tissue Inventories: Many museums are now offering tissue storage for genetic research (i.e. Milwaukee Public Museum, Illinois Natural History Survey). Techniques for DNA extraction and genetic characterization can now identify new species and genetically unique populations from tissue samples. Samples can be stored for decades with simple ethanol or freezing facilities. It is recommended that such tissue collections be made across the LSW and made available for such research. Dedicated sampling trips are recommended into areas where genetic differentiation is likely (i.e. islands, pockets of remaining old growth, disjunct populations). In addition, tissue sampling should become standard practice where any sampling is undertaken Tissue sampling methods vary, but standard samples are blood, and toe, scale, or tail clips.
- Site Inventories: Inventory needs are usually site specific. Many public lands such as parks and forests, and many private lands managed as nature reserves, are in need of baseline inventories to guide land management and species conservation practices. These needs must be evaluated by individual land managers.

<u>Suggested Monitoring Needs in the LSW</u>:

- Reference Sites: See above. This should also be a top multi-disciplinary priority for monitoring, and conform to the concept of "intensive monitoring sites" in Bishop and Pettit (1992).
- Calling Frog Surveys: As discussed above, expanding these surveys into areas with poor coverage, and regional cooperation on data sharing and standards, would improve the utility of this monitoring effort. Utilizing the concept of "extensive monitoring sites" in Bishop and Pettit (1992) would be useful throughout the LSW.
- Terrestrial Amphibian Monitoring: A network of time and effort constrained sampling is recommended for monitoring these organisms. There is reason to believe that the biomass and abundance of this group of forest dwelling vertebrates has been greatly reduced since presettlement times (mostly due to eliminating old growth forests), and therefore declines may be routinely underestimated, if baseline data are representative of already suppressed levels. Abundance estimates should be evaluated by forest type and account for weather variables, so as to discern the effects of land management practices on amphibians, and obtain realistic estimates of natural biomass, production and nutrient cycles in undisturbed forests. This type of monitoring would best fit under the "intensive monitoring site" concept in Bishop and Pettit (1992).

- Mudpuppies: A monitoring program sufficient to detect trends should be established at sites determined through an inventory effort for this aquatic salamander. Effort constrained aquatic trapping can be used for efficient monitoring. This type of monitoring would best fit under the "intensive monitoring site" concept in Bishop and Pettit (1992), but will likely need to be set up as an independent network because of the single species approach.
- Turtles: A program of periodic turtle trapping, with permanent marking (shell notching, PIT tags), is recommended to characterize and monitor turtle populations in the LSW. Sites should be selected to be representative of the turtle fauna and habitats in the region. Repeated at 3-5 year intervals, data collected should monitor population trends, demographics, chemical contaminants, and disease. Turtle life history is such that there is usually no harvestable surplus, and population response is slow (high juvenile mortality, low adult recruitment). Turtles are long lived, tend to feed and live in sediments, and are therefore excellent bio-accumulators of chemical contaminants. This type of monitoring would best fit under the "intensive monitoring site" concept in Bishop and Pettit (1992), and may need to be set up as an independent network because of the focused species group and technique approach.
- Wood Turtles are a special case, being already threatened and in decline, susceptible to commercial collectors and disturbance from recreation, and dependant upon relatively undisturbed riverine systems. Several Wood Turtle studies are already underway in the LSW, but will not necessarily result in long term monitoring. These studies should form the basis of a monitoring program, with standard data collection (Foscarini and Brooks, 1997). Site locations and researcher contacts can be obtained from state DNRs in Michigan, Wisconsin and Minnesota, and should be kept confidential due to collecting concerns.
- Lizards: Little is known about the trends and status of the two skinks in the LSW. A monitoring program sufficient to detect trends should be established at sites determined through inventory efforts. Effort constrained pitfall trapping, and/or visual searching, can be used for efficient monitoring. This type of monitoring would best fit under the "intensive monitoring site" concept in Bishop and Pettit (1992), and may need to be set up as an independent network because of the focused species group and technique approach.
- Snakes: Snakes are notoriously hard to inventory and monitor, due to secretive and cryptic natures, and poor response to trapping. Nevertheless, a variety of effort constrained trapping and visual search techniques can be used, including drift fences with funnel traps, and cover objects. Efficacy of techniques is often dependant upon careful microhabitat selection, and familiarity with snake behavioral responses to weather, underscoring the importance of using experienced herpetologists for field work. Cover object and drift fence stations are recommended at long term monitoring sites. This type of inventory would best fit under the "intensive monitoring site" concept in Bishop and Pettit (1992).

Conservation and Management Issues:

Turtles:

Michael Klemens book *Turtle Conservation* (Klemens, 2000) is recommended reading for anyone involved in turtle management and conservation. A realization that life history parameters for most turtle species do not allow for harvest of adults, and that populations cannot sustain elevated mortality of adults, is a paradigm that needs greater acceptance if turtle conservation is to be effective. Perhaps part of the difficulty is that for most game animals the opposite paradigm holds - to sustain populations adults can be harvested but young animals cannot. Turtles are typified by long lives (15-80 years), late reproductive maturity (6-20 years), lack of senescence (fecundity actually continues to increase with age), high juvenile mortality, low adult mortality, and delayed responses to demographic changes. Late reproductive maturity and long lives mean that populations are slow to respond to management measures, as well as population insults, and "living dead" populations may persist for decades without viability. Turtles cannot sustain increases in adult mortality. In the LSW, juvenile and adult mortality in all turtles has increased due to increases in nest predator abundance (racoons, skunks, etc.), road mortality, and loss of nesting areas (Shirose et al., 1996). Harvest of turtles for meat is also a factor in some areas.

Wood Turtle Conservation:

In the LSW, the most imperiled turtle is the Wood Turtle (Gardner, 1995). While still common in some stream systems in the LSW, most populations are already in the early stages of decline. Others will predictably disappear under current land use trends. Since populations are slow to respond to insults or enhancements, now is the time to put conservation measures in place, while sustainable populations still exist. Problems include habitat loss, elevated nest and adult mortality, collection for pets and food, and recreational disturbance. There are direct negative correlations between recreational use of rivers and Wood Turtle numbers (Ernst et al., 1994; Klemens, 2000). Habitat requirements are often large and complex, including streams, stream banks, and lands adjacent to streams (Ernst et al., 1994; Kaufmann, 1995; Buech and Nelson, 1997; Buech et al., 1997). Conflicts with logging, fisheries management, agriculture, urbanization, and recreation are pervasive (Saumure and Bider, 1998).

In Minnesota populations within the LSW are considered stable and secure (Buech and Nelson, 1997), but possibly threatened by increased human activity (ATV's, logging, canoeing) which may degrade habitat or result in direct mortality/collecting (Carol Hall, personal communication). Recommendations for preventing declines are: a) protect Wood Turtles from exploitation for food, biological supply and pets; b) accurately determine distribution and status; and c) incorporate Wood Turtle habitat needs in river management plans. The latter is especially important in the LSW, where stable populations can be maintained through management. Buech and Nelson (1997) offer the following management issues to consider while developing river management plans (see their paper for further discussion of the points). These recommendations are appropriate throughout the LSW.

- Identify and preserve nesting areas
- Avoid channelization, stream bank restoration, and impoundments
- Consider Wood Turtle nests in impoundment discharge plans
- Minimize recreation in vicinity of nesting areas
- Avoid transportation corridors in the riparian zone

- Discourage nesting on roadsides, especially near stream crossings
- Maintain in-stream woody debris
- Maintain riparian forest habitat
- Minimize sediment, pollution and pesticide loading.

Forestry Practices:

Logging is a major industry in the LSW, and one that has indelibly transformed the landscape and ecology of the entire region. Large areas of plantations, especially conifer plantations, are uninhabitable for most amphibians and reptiles, some of which cannot even move across these unnaturally warm, dry, acidic and sterile stands. Recognition of the profound ecological ramifications of keeping forests young, and altering natural tree species assemblages, has been slow in coming. Nevertheless, forestry practices are perhaps the single most visible and pervasive process affecting amphibian and reptile distribution and trends in the LSW today and historically, not least because of the huge area involved. Nearly all amphibians increase in abundance with forest age, as a consequence of older forests being cooler, moister, and having more downed woody debris and thicker litter - all favorable to amphibians (Ash and Bruce, 1994; Dupuis, 1997; Waldick, 1997). Many snakes prefer more open canopy, warmer environments, and may benefit from clearing. However, other snakes are dependant upon amphibians as prey, which do best in old growth (especially Northern Ring-necked Snakes which prey almost exclusively on Red-backed Salamanders). The consequences of deforestation for Wood Turtles are indirect, and include siltation of streams, and the influx of roads and human recreation that follows logging. Logging has far reaching impacts on water quality, affecting most herps.

These problems modern forestry presents for amphibians and reptiles require aggressive responses in policy, research, and management practices. Impacts of forestry practices to amphibians and reptiles should be incorporated into forestry planning, policy and environmental impact assessments. This incorporation should include not just threatened and endangered species, but all forest amphibians and reptiles. The goal should be to keep common species common, and recognize the major roles they play in forest ecology in terms of biomass, nutrient cycling, food webs and ecosystem sustainability. Quantifying responses to forestry practices will require the reference sites recommended above, for baseline comparisons to be made. These reference sites should be ideally unaffected by logging.

Global Warming:

Ovaska (1997) and Herman and Scott (1992) examined the vulnerability of amphibians in Canada to global warming and increased solar ultraviolet radiation. Because amphibians and reptiles have poor mobility, and poor barrier crossing ability, they are not expected to be able to respond to global warming by moving with climate change, as could, for example, birds or butterflies. Instead, they will largely be “trapped” where they are and have to respond to a warmer, drier climate. Most amphibian species are expected to decline as a result, while reptiles may increase or decrease, depending on life history needs. These predictions should be refined through more comprehensive research, and conservation strategies planned accordingly, which might include insuring the security of breeding ponds, or human assisted translocations with appropriate safeguards (see Dodd and Seigel, 1991).

Chemical Contaminants, including Fertilizers and Pesticides:

Chemical contaminants are a pervasive problem in the LSW, and a comprehensive research program into effects on amphibians and reptiles is recommended, beginning by a review of the current literature. The Reptile and Amphibian Toxicology Literature database is a recommended starting point (also see Berrill et al., 1997; Bonin et al., 1997; Linder et al., 2000). Egg and embryonic survival of amphibians in relation to pH and contaminant loads, forest dwelling amphibian response to soil pH, and bioaccumulation of toxins in Mudpuppies and turtles, are topics warranting review. Recently, Hayes (2002) found that the common pesticide Atrazine compromises reproduction in frogs at realistic environmental exposures, and without observable outward signs of problems (affected are gonad and larynge development, and testosterone levels). Such subtle chemical effects may be much more widespread in amphibians and reptiles than realized (and humans, for that matter), and are in urgent need of investigation.

Commercial Harvest of Herptiles:

Commercial harvest of herptiles is not currently a problem in the LSW, but may become so. An exception is for Wood Turtles, for which illegal collecting is a problem. Stepped up enforcement coupled with denying easy public access to Wood Turtle streams is a proper response. Should harvest pressures develop for any species within the LSW, management of resources should follow sound biological principles for sustainable harvest. Raw data to calculate sustainable harvest levels is missing for most herptiles (life tables), and therefore no harvests should be allowed until these data are acquired. See Galbraith, et al. (1997), and Klemens (2000) for discussion on turtles.

Urbanization:

Rapid development and road building is occurring in many parts of the LSW, and land use planning needs to begin taking into account wildlife concerns. Shoreline development is particularly worrisome as impacting many species of frogs and snakes. Development in riparian corridors can have profound impacts on stream quality (Mudpuppies) and Wood Turtles. The cumulative impacts of forest fragmentation must also be taken into account for species with large patch size requirements, such as interior forest breeding salamanders. Without widespread attention given to these issues at all levels of government and planning, much wildlife will disappear from the region as the inexorable march of humankind overwhelms natural systems. Global warming is expected to bring even more people to the region, and planning for growth will also be a recipe for reducing biodiversity unless measures are taken immediately to instill a conservation ethic in land use and planning agencies.

Amphibian Decline and Malformations:

Amphibian decline and malformation has received much attention, and causes are fairly well known (Blaustein and Wake, 1995; Green, 1997, Lannoo, 1998). Habitat loss, fragmentation and degradation is the major causal factor in decline - and easily addressed through smart land use planning and acquisition of reserves. Also playing roles in declines and malformations, within this background of habitat loss, are chemical contaminants, increasing ultra-violet radiation, and outbreaks of diseases (Crawshaw, 1997) and parasites. The latter may be

compounded by immune deficiency problems associated with the former two, and continuing research in these areas is sorely needed.

Fish introductions into wetlands are also contributing to amphibian decline in parts of the United States, and may expand into the LSW (Lannoo, 1997). Placing fish into freeze-out ponds should be banned, as it eliminates breeding habitat for most amphibians.

Another pressing need as regards amphibian decline is the mapping and protection of small wetlands (forested vernal pools, ephemeral wetlands, isolated ponds), which are critical breeding habitats and often inadequately protected. These wetlands can be less than half an acre in size, and do not contain fish. To be effective, protections must include the terrestrial core habitat surrounding the breeding pond, which extends 350-500 feet from the wetland boundary (Semlitsch, 1997). In many parts of the LSW, vernal pools are ubiquitous, and protections could be effective by selecting a grid of protected "amphibian production areas" in each landscape, connected by managed forest where such wide buffers are impacted only periodically. In other regions where such wetlands are scarce, eliminating the wetland or it's associated core terrestrial habitat will likely eliminate all pond breeding amphibians as well. It is recommended that mapping, and the development of strategies for preserving these habitats, begin as soon as possible. Strategies will likely require education, changes in land use planning, changes in agricultural practices, and changes in timber harvest protocols.

GIS Project:

Attached to this report are digital files developed for this review, as an Arcview project. These files can be used for a variety of geographic analyses, mapping, and tracking of distribution records. GIS project development should coordinate with herp atlases and surveys in the LSW, as well as with Natural Heritage Inventory databases. Continuing development of the GIS project would provide useful tools for investigating environmental and human correlates with herptile distribution and biology, and in natural resource conservation planning.

Closing

In closing, there is much work to be done in the LSW to ensure that common species remain common, and to recovery species that have declined. Multi-disciplinary, long term programs will be necessary. The most challenging aspect will undoubtedly be funding. The region is still vast and relatively undisturbed, however, raising hope that it can be conserved. To do so will require stubborn and persistent attention to a multitude of existing and forthcoming environmental problems, and a serious effort at research, inventory and monitoring to not only acquire needed basic baseline data, but to acquire the understanding of ecological and life history processes necessary to implement effective conservation. This is our challenge.

Regional Literature Review

This review lists important regional herp publications. It is not meant to be exhaustive.

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Table 1: Status Listings

Legend

ON Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Designation codes: END-R = Regulated under provincial Endangered Species Act. END = Endangered. THR = Threatened. VUL = Vulnerable. SC = Special Concern. EXP = Extirpated. EXT = Extinct. NIAC = Not in Any Category. NAR = Not At Risk. IND = Indeterminate. DD = Data Deficient.

MNR Status (MNR): Status assigned by the Ontario Ministry of Natural Resources. EXT Extinct. Any species formerly native to Ontario that no longer exists. EXP Extirpated. Any native species no longer existing in the wild in Ontario, but existing elsewhere in the wild. END Endangered. Any native species that, on the basis of the best available scientific evidence, is at risk of extinction or extirpation throughout all or a significant portion of its Ontario range if the limiting factors are not reversed. Endangered species are protected under the province's Endangered Species Act. THR Threatened. Any native species that, on the basis of the best available scientific evidence, is at risk of becoming endangered throughout all or a significant portion of its Ontario range if the limiting factors are not reversed. VUL Vulnerable. Any native species that, on the basis of the best available scientific evidence, is a species of special concern in Ontario, but is not a threatened or endangered species. IND Indeterminate. Any native species for which there is insufficient scientific information on which to base a status recommendation. NIAC Not In Any COSSARO Category. Any native species evaluated by COSSARO which does not currently meet criteria for assignment to a provincial risk category.

MI Current species status under the Michigan Endangered Species Act. Endangered species (E): Any species of fish, plant life, or wildlife that is in danger of extinction throughout all or a significant part of its range, other than a species of insecta determined by the Department, or the Secretary, of the United States Department of the Interior to constitute a pest whose protection under this part would present an overwhelming and overriding risk to humans. Threatened species (T): Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Special Concern (SC): While not afforded legal protection under the Act, many of these species are of concern because of declining or relict populations in the state. Should these species continue to decline, they would be recommended for Threatened or Endangered status. Protection of Special Concern species now, before they reach dangerously low population levels, would prevent the need to list them in the future by maintaining adequate numbers of self-sustaining populations within Michigan. Some other potentially rare species are listed as of Special Concern pending more precise information on their status in the state; when such information becomes available, they could be moved to Threatened or Endangered status or deleted from the list. Extirpated (EX): Any species which can no longer be found in the state of Michigan, but which can be found elsewhere in the world. Extinct (EXT): Any species which can no longer be found anywhere in the world.

MN Minnesota Department of Natural Resources Rankings: A species is considered Endangered (E), if the species is threatened with extinction throughout all or a significant portion of its range within Minnesota. A species is considered Threatened (T), if the species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range within Minnesota.A species is considered a Species of Special Concern (SC), if although the species is not endangered or threatened, is extremely uncommon in Minnesota, or has unique or highly specific habitat requirements and deserves careful monitoring of its status. Species on the periphery of their range that are not listed as threatened may be included in this category along with those species that were once threatened or endangered but now have increasing or protected, stable populations.

WI Protection category designated by the Wisconsin DNR. END= Endangered. THR= Threatened. SC= Special Concern. WDNR and federal regulations regarding Special Concern species range from full protection to no protection. The level of protection currently follows: SC/P= fully protected. SC/N= no laws regulating use, possession, or harvesting. SC/H= take regulated by establishment of open and closed seasons. SC/FL= federally protected as endangered or threatened, but no so designated by WDNR. SC/M= fully protected by federal and state laws under the Migratory Bird Act

NATURAL HERITAGE GLOBAL AND STATE RANKS

GLOBAL RANKS

G1 critically imperiled globally because of extreme rarity (5 or fewer occurrences range-wide or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

G2 imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g. a single western state, a physiographic region in the East) or because of other factor(s) making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.

G4 apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.

G5 demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.

GH of historical occurrence throughout its range, i.e. formerly part of the established biota, with the expectation that it may be rediscovered (e.g. Bachman's Warbler).

GU possibly in peril range-wide, but status uncertain; need more information.

GX believed to be extinct throughout its range (e.g. Passenger Pigeon) with virtually no likelihood that it will be rediscovered.

G? Unranked, or, if following a ranking, rank tentatively assigned (e.g. G3?).

Q Denotes that the taxonomic status of the species, subspecies, or variety is questionable.

T Denotes that the rank applies to a subspecies or variety.

? Denotes inexact numeric rank (i.e. G4?).

STATE RANKS

S1 critically imperiled in the state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation in the state.

S2 imperiled in state because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.

S3 rare or uncommon in state (on the order of 21 to 100 occurrences).

S4 apparently secure in state, with many occurrences.

S5 demonstrably secure in state and essentially ineradicable under present conditions.

SA accidental in state, including species (usually birds or butterflies) recorded once or twice or only at very great intervals, hundreds or even thousands of miles outside their usual range.

SE an exotic established in the state; may be native elsewhere in North America (e.g. house finch or catalpa in eastern states).

SH of historical occurrence in state and suspected to be still extant.

SN regularly occurring, usually migratory and typically nonbreeding species.

SR reported from state, but without persuasive documentation which would provide a basis for either accepting or rejecting the report.

SRF reported falsely (in error) from state but this error persisting in the literature.

SU possibly in peril in state, but status uncertain; need more information.

SX apparently extirpated from state

– No status, not tracked, or data not available

Table 1: Status and Natural Heritage Ranks of Lake Superior Watershed Herps

SPECIES	Ontario COSEWIC/MNR/NHI Rank	Michigan MI Status/NHI Rank	Minnesota MN Status/NHI Rank	Wisconsin WI Status/WI Protection/NHI Rank	NHI Global Rank
Common Mudpuppy, *Necturus maculosus maculosus*	/NIAC/S4	--	--	--	G5
Central Newt, *Notophthalmus viridescens louisianensis*	/ /S4?	--	--	--	G5T5
Red-spotted Newt, *Notophthalmus viridescens viridescens*	/ /S5	--	--	--	G5T5
Spotted Salamander, *Ambystoma maculatum*	/ /S4	--	--	--	G5
Eastern Tiger Salamander, *Ambystoma tigrinum tigrinum*	/ /SX	--	--	--	G5
Blue-spotted Salamander, *Ambystoma laterale*	/ /S4	--	--	--	G5
Four-toed Salamander, *Hemidactylium scutatum*	/NIAC/S4	--	SC	SC/N/S3	G5
Eastern Red-backed Salamander, *Plethodon cinereus*	/ /S5	--	--	--	G5
Eastern American Toad, *Bufo americanus americanus*	/ /S5	--	--	--	G5
Western Chorus Frog, *Pseudacris triseriata*	/ /S4	--	--	--	G5
Boreal Chorus Frog, *Pseudacris maculata*	/ /S5	SC/S1	--	--	G5
Northern Spring Peeper, *Pseudacris crucifer crucifer*	/ /S5	--	--	--	G5
Eastern Gray Treefrog, *Hyla versicolor*	/ /S5	--	--	--	G5
Cope's Gray Treefrog, *Hyla chrysoscelis*	/ /SR	--	--	--	G5
American Bullfrog, *Rana catesbeiana*	/ /S4	--	--	SC/H/S3	G5

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SPECIES	Ontario COSEWIC/MNR/NHI Rank	Michigan MI Status/NHI Rank	Minnesota MN Status/NHI Rank	Wisconsin WI Status/WI Protection/NHI Rank	NHI Global Rank
Northern Green Frog, *Rana clamitans melanota*	/ /S5	--	--	--	G5
Mink Frog, *Rana septentrionalis*	/ /S5	--	--	--	G5
Wood Frog, *Rana sylvatica*	/ /S5	--	--	--	G5
Northern Leopard Frog, *Rana pipiens*	/NIAC/S5	--	--	--	G5
Pickerel Frog, *Rana palustris*	/NIAC/S4	--	--	//S3S4	G5
Eastern Snapping Turtle, *Chelydra serpentina serpentina*	/ /S5	--	SC	--	G5
Wood Turtle, *Clemmys insculpta*	SC/VUL/S2	SC/S2S3	T	T/-/S3	G4
Blanding's Turtle, *Emydoidea blandingii*	/ /S3?	SC/S3	T	T/-/S3	G4
Western Painted Turtle, *Chrysemys picta bellii*	/ /S4	--	--	--	G5T5
Midland Painted Turtle, *Chrysemys picta marginata*	/ /S5	--	--	--	G5T5
Northern Map Turtle, *Graptemys geographica*	/ /S4	--	--	--	G5
Eastern Spiny Softshell, *Apalone spinifera spinifera*	THR/THR/S3	--	--	--	G5
Common Five-lined Skink, *Eumeces fasciatus*	SC/VUL/S3	--	SC	--	G5
Northern Prairie Skink, *Eumeces septentrionalis septentrionalis*		--	--	--	G5
Northern Ring-necked Snake, *Diadophis punctatus edwardsii*	/ /S4	--	--	SC/N/S3?	G5T5

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SPECIES	Ontario COSEWIC/MNR/NHI Rank	Michigan MI Status/NHI Rank	Minnesota MN Status/NHI Rank	Wisconsin WI Status/WI Protection/NHI Rank	NHI Global Rank
Smooth Greensnake, *Opheodrys vernalis*	/ /S4	--	SC	--	G5
Western Foxsnake, *Elaphe vulpina vulpina*		--	SC	--	G5
Eastern Milksnake, *Lampropeltis triangulum triangulum*	/ /S4	SC/S3S4	--	--	G5
Eastern Hog-nosed Snake, *Heterodon platirhinos*	SC/VUL/S3	--	--	--	G5
Bullsnake, *Pituophis catenifer sayi*		--	SC	SC/N/S3S4	G5
Dekay's Brownsnake, *Storeria dekayi*	/ /S5	--	--	--	G5
Northern Red-bellied Snake, *Storeria occipitomaculata occipitomaculata*	/ /S5	--	--	--	G5
Red-sided Gartersnake, *Thamnophis sirtalis parietalis*	/ /S4?	--	--	--	G5T?
Eastern Gartersnake, *Thamnophis sirtalis sirtalis*	/ /S5	--	--	--	G5T?
Northern Watersnake, *Nerodia sipedon sipedon*	/ /S5	--	--	--	G5T5

Appendix 1: Museum Material

Summary of museum material for amphibians and reptiles of the Lake Superior Watershed obtained through simple inquiry. This is not intended as an exhaustive or completely accurate list of available material, but rather as a starting point for persons interested in material for the region. Institutions should be contacted for up-to-date and complete lists, and material should be verified before use. For this search, holdings of Wisconsin material for some institutions is more accurately reflected than holdings from other states/provinces, due to exhaustive canvassing by the Wisconsin Herp Atlas (especially the James Ford Bell Museum and the various University of Wisconsin collections). This is a result of collections not being computerized, but Wisconsin material being independently digitized by the Wisconsin Herp Atlas. Significant collections not represented here are the Royal Ontario Museum and the University of Guelph.

Acronyms:

AMNH	American Museum of Natural History, New York
CAS	Chicago Academy of Sciences
CASSF	California Academy of Sciences, San Francisco
CM	Carnegie Museum, Pittsburgh, PA
CU	Cornell University, Ithaca, NY
FMNH	Field Museum of Natural History, Chicago
INHS	Illinois Natural History Survey, Urbana-Champaigne, IL
JFBM	James Ford Bell Museum of Natural History, Minneapolis, MN
KU	Kansas University Museum of Natural History, Lawrence, KA
LACM	Los Angeles County Museum of Natural History, Los Angeles, CA
MPM	Milwaukee Public Museum, Milwaukee, WI
MSWB	Museum of Southwestern Biology, Univ of New Mexico, Albuquerque, NM
MVZ	University of California at Berkely, Museum Vertebrate Zoology
OMNH	Sam Noble Oklahoma Museum of Natural History, Norman, OK
OU	Ohio University, Athens, OH
RM	Richter Museum, University of Wisconsin, Green Bay, WI
SIU	Southern Illinois University, Carbondale, IL
TU	Tulane University, Baton Rouge, LA
UCB	University of Colorado at Boulder
UIMNH	University of Illinois Museum of Natural History, Urbana, IL
UMMZ	University of Michigan, Ann Arbor, MI
UNL	University of Nebraska, Lincoln, NE
USNM	United States National Museum, Washington, DC
UWS	University of Wisconsin, Superior, WI
UWSP	University of Wisconsin, Stevens Point, WI
UWZ	University of Wisconsin, Madison, WI

Species Summaries:

Species	Institution (N specimens).
Acris crepitans blanchardi	UWZ (1). Total = 1. Probably in error.
Ambystoma laterale complex	AMNH (19); CM (2); FMNH, IL (4); INHS (1); JFBM (7); MPM (65); RM (2); USNM (13); MVZ (3); UIMNH (7); UMMZ (31); UWSP (3); UWS (16); UWZ (50). Total = 223. Includes *A. laterale, A. jeffersonianum, A. tremblayi.*
Ambystoma maculatum	FMNH, IL (1); MPM (45); RM (6); MVZ (6); UMMZ (10); UWSP (2); UWS (3); UWZ (2). Total = 75.
Ambystoma texanum	UWGB (1). Total = 1. Considered in error.
Ambystoma tigrinum	MPM (2); UWS (1). Total = 3.
Apalone spinifera spinifera	MPM (6).
Bufo americanus americanus	AMNH (2); CASSF (27); CM (6); FMNH (28); INHS (7); JFBM (4); MPM (236); MSWB (2); OU (1); RM (1); USNM (19); MVZ (6); UCB (2); UIMNH (4); UMMZ (107); UWZ (96); UWSP (8); UWS (57). Total = 613.
Chelydra serpentina	CM (8); FMNH, IL (1); INHS (2); MPM (10); RM (1); UMMZ (14); UWSP (2); UWS (6). Total = 44.
Chrysemys picta	AMNH (2); CM (68); FMNH, IL (5); INHS (1); MPM (38); RM (2); TU (20); USNM (5); MVZ (1); UMMZ (47); UWZ (1); UWSP (1); UWS (22). Total = 213.
Clemmys insculpta	CM (38); CAS (1); MPM (16); RM (1); UMMZ (18); UWZ (1); UWS (6). Total = 81.
Diadophis punctatus edwardsii	FMNH, IL (2); MPM (18); INHS (2); UMMZ (17); UWSP (1); UWS (5); UWZ (2). Total = 47.
Elaphe vulpina vulpina	CM (2); FMNH (1); JFBM (2); MPM (5); RM (2); USNM (1); UMMZ (7); UWSP (2); UWS (2). Total = 24.
Emydoidea blandingii	MPM (15); USNM (1); UMMZ (1); UWS (1); Total = 18.
Eumeces fasciatus	CM (1); MPM (1); UMMZ (5). Total = 7.
Eumeces septentrionalis	FMNH (27); MPM (22); USNM (3); UNL (4); UWZ (7); UWS (6). Total = 69.
Graptemys geographica	FMNH (1); UMMZ (1). Total = 2.
Hemidactylium scutatum	CM (5); JFBM (1); MPM (72); RM (1); UMMZ (6); UWZ (1); UWSP (2); UWS (4). Total = 92.
Heterodon platirhinos	FMNH (1); JFBM (1); MPM (10); OMNH (2); USNM (2); UWZ (2); UWSP (1); UWS (3). Total = 22.
Hyla chrysoscelis	MPM (38); UWZ (12). Total = 50.
Hyla chrysoscelis/versicolor	JFBM (2); KU (1); RM (1); USNM (2); UMMZ (5); UWZ (3); UWSP (2); UWS (7). Total = 23.
Hyla versicolor	AMNH (1); CASSF (2); FMNH (5); MPM (147); UIMNH (1); UMMZ (5); UWZ (30). Total = 191.
Lampropeltis triangulum	UMMZ (5). Total = 5.
Necturus maculosus	CASSF (1); FMNH (8); INHS (1); JFBM (1); MPM (6); USNM (5); UIMNH (2); UMMZ (29); UWZ (5); UWSP (1); UWS (2). Total = 61.
Nerodia sipedon sipedon	AMNH (12); CM (2); FMNH (5); JFBM (2); MPM (11); USNM (3); UIMNH (1); UMMZ (12); UWZ (9); UWSP (1). Total = 58.
Notophthalmus viridescens louisianensis	FMNH (2); MPM (65); USNM (2); UMMZ (57); UWSP (2); UWS (22). Total = 150.
Notophthalmus viridescens viridescens	CM (1); FMNH (2). Total = 3.
Opheodrys vernalis	FMNH (6); INHS (1); JFBM (8); MPM (24); OU (4); RM (1); USNM (3); UMMZ (49); UWZ (12); UWSP (1); UWS (18). Total = 127.
Pituophis catenifer sayi	MPM (1). Total = 1.
Plethodon cinereus	AMNH (1); CM (165); FMNH (13); INHS (2); MPM (126); MSWB (22); RM (1); USNM (46); MVZ (40); UMMZ (1,649); UWZ (26); UWSP (9); UWS (80).

	Total = 2,180.
Pseudacris crucifer crucifer	AMNH (1); CM (1); FMNH (20); INHS (2); MPM (154); RM (1); USNM (13); MVZ (6); UIMNH (2); UMMZ (47); UWZ (34); UWSP (3); UWS (41). Total = 325.
Pseudacris maculata	USNM (14). Total = 14.
Pseudacris triseriata	FMNH (6); MPM (31); OU (1); USNM (2); UMMZ (6); UNL (1); UWZ (1); UWSP (3); UWS (5). Total = 56.
Rana catesbeiana	CASSF (1); FMNH (8); INHS (1); JFBM (2); MPM (19); USNM (2); MVZ (11); UMMZ (7); UWZ (12); UWSP (1); UWS (15). Total = 79.
Rana clamitans melanota	AMNH (6); CM (2); FMNH (48); INHS (15); JFBM (7); MPM (116); MSWB (7); OU (2); RM (2); USNM (18); MVZ (8); UCB (2); UIMNH (14); UMMZ (211); UWZ (1); UWSP (10); UWS (69). Total = 538.
Rana palustris	MPM (12); OU (1); USNM (5); UMMZ (4). Total = 22.
Rana pipiens	AMNH (7); CASSF (24); CM (9); FMNH (38); INHS (14); JFBM (2); MPM (163); OU (1); OMNH (2); USNM (14); UCB (2); UIMNH (3); UMMZ (102); UWSP (7); UWS (89). Total = 477.
Rana septentrionalis	AMNH (5); CASSF (47); CM (12); FMNH (26); INHS (2); JFBM (2); MPM (47); USNM (24); UIMNH (1); UMMZ (91); UWSP (5); UWS (18). Total = 280.
Rana sylvatica	AMNH (6); CASSF (12); CM (7); FMNH (25); INHS (7); MPM (124); MSWB (1); RM (4); USNM (62); MVZ (1); UIMNH (5); UMMZ (105); UNL (1); UWZ (2); UWSP (10); UWS (29). Total = 401.
Regina septemvittata	UMMZ (2). Total = 2. Just outside LSW.
Sistrurus catenatus catenatus	UMMZ (4). Total = 4. Just outside LSW.
Sternotherus odoratus	TU (1). Total = 1. Probably in error.
Storeria dekayi	UMMZ (1); UWZ (5). Total = 6.
Storeria occipitomaculata	AMNH (1); CASSF (3); CM (4); CU (4); FMNH (9); INHS (5); JFBM (3); MPM (68); OU (3); SIU (1); USNM (20); UMMZ (94); UNL (2); UWZ (18); UWSP (3); UWS (43). Total = 281.
Thamnophis radix	UWZ (1). Total = 1. Probably in error.
Thamnophis sauritus	UMMZ (2). Total = 2. Just outside LSW.
Thamnophis sirtalis	AMNH (7); CASSF (14); CM (2); CU (14); FMNH (18); INHS (8); JFBM (2); LACM (1); MPM (137); OU (1); RM (1); USNM (19); UIMNH (1); UMMZ (138); UWZ (86); UWSP (6); UWS (42). Total = 497.

Institutional Specimen Totals for the LSW Region (see caveats above).

AMNH	70	OMNH	4
CAS	1	OU	14
CASSF	131	RM	28
CM	335	SIU	1
CU	18	TU	21
FMNH	319	UCB	6
INHS	69	UIMNH	43
JFBM	46	UMMZ	2,889
KU	1	UNL	8
LACM	1	USNM	298
MPM	1,850	UWS	612
MSWB	32	UWSP	86
MVZ	82	UWZ	420
		Total	7,385